COPY FOR MR. J. ALLAN ROSS

HYDRO-ELECTRIC INQUIRY COMMISSION

GENERAL REPORT

THE QUEENSTON-CHIPPAWA POWER DEVELOPMENT

VOLUME I —HISTORY AND DESCRIPTION
VOLUME II—COST, CAPACITY AND OPERATION
VOLUME III—ESTIMATES AND APPROPRIATIONS
VOLUME IV—REASONS FOR INCREASED COST

VOLUME IV

JOSEPH H. W. BOWER
SECRETARY

THE QUEENSTON-CHIPPAWA POWER DEVELOPMENT

VOLUME IV

INDEX TO SECRETARY'S REPORT

ON

THE QUEENSTON-CHIPPAWA POWER DEVELOPMENT

VOLUME I

HISTORY AND DESCRIPTION

INDEX TO SECRETARY'S REPORT

OF

THE STRANGFORD-CONLEARA POWER DEVELOPMENT

VOLUME I

HISTORY AND INVESTIGATION

PART I - INTRODUCTION

Page

PART II - HISTORICAL

PART III - GENERAL DESCRIPTION

PART IV - CONSTRUCTION PROCEDURE

INDEX (Continued)

VOLUME II

COST, CAPACITY AND OPERATION

VOLUME III

ESTIMATES AND APPROPRIATIONS

INDEX (Continued)

VOLUME IV

REASONS FOR INCREASED COST

PART IX - REASONS FOR INCREASED COST

PART X - CONSTRUCTION METHODS & MANAGEMENT

THE QUEENSTON-CHIPPAWA POWER DEVELOPMENT

VOLUME IV

REASONS FOR INCREASED COST

PART II - REASONS FOR INCREASED COST

Section 36

GENERAL

The second question referred to this Commission by Letters Patent reads as follows:

"The reasons for increases from time to time in the estimates for the Queenston-Chippawa Power Development."

Estimated costs may be increased or decreased from time to time on construction work for various reasons, but under normal conditions, with the cost of labour and materials constant, changes in estimates are usually caused by changes in design entailing a change in the quantities and a resulting variation in cost.

A contractor, when preparing a tender, assures himself that the plans and specifications, on which his estimate is based, cover in a comprehensive and definite way the work contemplated. If discrepancies, omissions or other irregularities are observed by him, he either makes adequate provision for them in his tender, or draws them to the attention of his client.

Forms of Contracts

There are many forms of contracts under which work is carried out, but they may be divided into two general classes. The first is that in which the contractor submits a definite tender or "firm bid" agreeing to do certain work for a fixed amount or "lump sum". The second general class embraces contracts made on what is commonly known as the "cost plus" basis, being made up of actual cost to which a sum is to be added. Contracts of this kind vary in form, but in their simplest form constitute an agreement between owner and contractor, whereby the contractor supplies all necessary labour and materials, and receives a fixed percentage of the cost as his remuneration or profit. Under this type of contract the contractor takes no financial risk, for the cost of the work plus his profit is guaranteed to him by his contract. It is apparent that on this basis the risks of contracting on a "lump sum" basis are eliminated. Much work has been done under contracts of this kind, but in order to give greater protection to the owner modified forms of the "cost plus" contract have been introduced.

Probably the two most usual of these modified forms of "cost plus" contract are those commonly known as "cost plus a fixed fee" and "upset price" contracts. Under the first, the contractor is required to submit an estimate of the actual cost of the work contemplated, and, in addition, to quote a fixed fee for carrying it out. As an illustration, the cost of a job may be estimated at $250,000 and the contractor may ask a fixed fee of $20,000 in addition to the cost, for carrying out the work. If the work costs $300,000, his fee will remain the same, but the ratio of profit to cost is reduced. If the work costs less than his estimate, the owner benefits by the saving and while the fixed

fee remains the same, the contractor's ratio of profit to cost increases.

Under the "upset price" form of contract, additional restrictions are imposed to safeguard the interests of the owner. Such contracts usually provide that the contractor, in the event of his estimate being exceeded, must bear all or at least a part of the extra cost, while if savings are effected, some distribution of these is made between owner and builder. The method by which savings or excess costs are distributed varies considerably with different contracts.

There is little doubt that a contractor, when doing work on a "lump sum" basis, does it in the most efficient way he can, for his profit depends on his efficiency. This form of contract also enables the owner to know in advance what his expenditure will be, for the contractor takes all the risk, and is presumed to have provided for all contingencies.

Under the other forms of contract discussed, an endeavour has been made to provide for the uncontrollable incidents that occur on almost every job. Under the straight "cost plus" arrangement, the situation is ideal, so far as reducing risk to the contractor is concerned, so, while the modified forms of this contract recognize that there are certain risks inherent in construction work on which a contractor should not be asked to speculate, restrictions are imposed which protect the client to a greater degree than the straight "cost plus" form.

Though many contractors still prefer the "lump sum" contract, hoping through it to make at times a greater profit than can be made on a "cost plus" basis, many of the best known contractors have conducted their

business in recent years entirely on some form of "cost plus" contract.

Contracting - A Specialized Business

Large industrial concerns, railway companies and Governments usually consider it wise to employ the services of contractors to do their construction work, and this policy is adopted because it is known that more efficient results are obtained from labour and other economies effected by an experienced private contractor. There are, of course, qualified corporations which do their own work, but they are the exceptions to the rule, for it is common knowledge that the efficiency and morale of workmen is much lower when the work on which they are employed is being done by a Government Department, than it is when the work is in the hands of a private contractor. In the case of railway corporations, which one would think well-fitted to do construction work, it will be found that lines, stations and large new work generally are given to private contractors, under some form of contract, and that the company itself does maintenance and small work only. Large industrial concerns follow the same policy for it is generally realized that a reasonable profit paid to a reputable builder is more than offset by the service rendered.

Section 37

METHOD OF CONDUCTING THE WORK

Up to 1916, the Commission had carried on the construction of the majority of its works under contracts with private contractors. When the recommendation of the Chairman of the Commission was submitted to the Government under date of September 13th, 1916, there is no doubt that the Government was led to believe that it was contemplated that the construction

of the Queenston-Chippawa Power Development would be carried out on a similar basis, for the Chairman of the Commission states as follows:

> "There is still available sufficient money from the estimates provided by the Government to take care of the preparation of specifications, detailed drawings, etc. necessary for tendering upon the works during the present Fall and Winter."

The Commission at a later date apparently conceived the idea of carrying on the work itself, but no intimation seems to have been given to the Government as to the change of policy in this respect. The decision of the Commission to carry on the construction is a matter of official record in their Minutes under date of November 22nd, 1916. The Minute in question reads as follows:

> "Earnest consideration was given to the subject of the Chippawa-Queenston Development. The Chief Engineer's report in connection with the construction of the canal and plant was carefully discussed. It was finally decided, in view of the exhaustive investigations that had been made of the subject showing the large saving which would be effected, that the Commission would undertake the work direct for the whole of this development and that an Order-in-Council should be applied for at once in order that immediate steps be taken for the preparatory work."

The Commission apparently gave publicity to the decision which it had reached as the matter is made the subject of an important comment in a letter of December 12th, 1916, signed by the Premier, Sir William Hearst, and addressed to the Honourable Mr. Lucas. In this letter, the Premier, after requesting information on various matters, states:

> "I note by the press that there is some thought on the part of the Commission of doing this work by day labor instead of by tender. If such should be the intention of the Commission, a full report as to the reasons for adopting this course. I

of the Immigration-Citizens Union Investment would be carried out on a stable basis, for the benefit of the Immigration states as follows:

> "There is still available sufficient money from the estimated provided by the Government to make sure of the completion of operations, Marshal Lowlands, etc. necessary for completing that work during the present full and fiscal."

The Committee at a later date apparently convinced the idea of carrying on the work itself, but as indicative weren't been given to the Government as to the change of policy in this respect. The decision of the Committee to carry on the construction is a matter of official record in their minutes under date of December 22nd, 1916. The minute in question reads as follows:

> "Owing available funds and work in the midst of the Immigration-Citizens Development. The chief Engineer's report is amended this with the continuation of the canal and place the specifically elements. It was finally decided, in view of the committee investigations that not been made of the minimum treating the large saving which would be effected, that the Committee would adjudicate the work direct for the whole of this development and that an Order-in-Council should be applied for at once in order that immediate steps be taken for the preparatory work."

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> "I note by the press that there is some thought on the part of the Commission of doing without by day labor instead of by tender. It may rightly be the intention of the Commission, a full report as to the reasons for adopting this course. I

have been advised that work has been closed down on the Welland Canal and at other points in Canada and that there is a very large amount of contractors' plants that will be lying idle for the next few years and that the present is a most opportune time to secure tenders so far as plant and the general organization of contractors are concerned. If the work is to be done by day labor I assume a very large plant will have to be purchased by the Commission, much of which will have to be disposed of at scrap prices when the contract is completed, whereas contractors under present conditions would, I am advised, only have to bear a small proportion of the cost for plant that would fall upon the Commission. The contractors on the work to which I refer have their engineers and general organization for the undertaking. If tenders are called for and reputable contractors bid on the work, we will have something definite to gauge the ultimate liability assumed by the Province. Without tenders we have nothing to guide us as to the cost, but the estimates of the Engineers. Although I have no doubt the Engineers have estimated the cost on a liberal scale to provide for contingencies, nevertheless, if the actual cost should seriously exceed the estimate and the Commission has not taken the precaution to secure tenders, room would be left for severe criticism. By what I have stated in this paragraph I am not expressing any view as to how the work should be done. I have no information upon which I could base an intelligent judgment one way or the other. I am simply bringing to your attention statements and arguments that have been made to me so that the Commission may consider them and advise me fully of their view with reference thereto."

This letter is remarkable in two respects: it shows that the Commission had not informed the Premier of its decision to do the work with its own organization, apparently allowing him to learn this important fact from the newspapers, though Mr. Lucas was a member both of the Commission and the Government, and the Chairman of the Commission, Sir Adam Beck, a member of the Legislature; and it also shows that when the Premier wrote the words, "without tenders we have nothing to guide us as to the cost, but the estimates of the Engineers", he evidently had in mind the possibility of the cost of the work exceeding the estimates.

have been advised that work has been already done on the Pelican Canal and at other points in Alberta and that there is a very large number of constructive plants that will be lying idle for the most few years and that the present is a most opportune time to secure labour at the so place and the general expenditure of construction has decreased. If this work is to be done by day labor I assume a very large plant will have to be purchased by the Canadian, many of which will have to be abandoned at the many points when the contract is completed, various auxiliary minor present facilities which, I am advised, only have to be a small proportion of the cost for plant that would fall upon the Provincial. The contractors on the work is which I refer have their machinery and general organization for the enterprise. If Tenders are called for and Provincial contractors bid on the work, we will have something definite to compare the relative liability assumed by the Province. Without tendors we have nothing to guide us as to the cost, but the estimates of the Engineers. Although I have no doubt the Engineers have estimated the cost on a liberal scale to provide for contingencies, perhaps theirs, if the normal cost should certainly exceed the estimate and the Commission has not been the promotion to secure labour, this would be fair ground for serious criticism. My view I have stated in this paragraph I do not consider any other as to the use the Province should be done. [illegible] information upon which I could base an intelligent judgment one way or the other. I am simply bringing to your attention statements and arguments that have been made to me that the Commission may consider them and act in the light of their view with reference thereto."

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Commission Calls for Tenders

During the month of December, 1916, after the Commission had decided to carry on the work with its own organization, the Chief Engineer of the Commission wrote to various contracting firms requesting them to submit certain tenders. The following is an extract from the evidence in reference to this:

Q.- The truth is, Mr. Gaby, isn't it, that you had decided and the Commission had decided before you called for these tenders at all?

MR. GABY: No sir, not at all. The Commission I do not believe in any way had discussed the matter in that way.

Q.- You called for these tenders on December 6th, 1916, and this is the Minute of November 22nd, 1916. (The Minute referred to is that quoted previously.)

A.- That was something which had escaped my attention. I did not know it was there.

Q.- That was before you called for tenders?

A.- I thought that was after.

Ev. 4590

It is difficult to understand why the Commission asked for tenders in view of the Minute of November 22nd, 1916, unless for the purpose of obtaining a check on the unit prices which the engineers were using at that time, or for the purpose of complying with the wish of the Premier. At all events, it is clear from evidence given before us that the contractors did not believe that the Commission was serious in its request for tenders. Mr. Larkin of Larkin & Sangster on being questioned on this matter stated:

Q.- Did you regard their request for tenders as a check more than asking for bona fide tenders?

Immunity Bills for Trusts

During the month of December, 1934, after the Committee had decided to carry on the work with its own organization, the Chief Examiner of the Commission wrote to various concerning firms requesting them to submit certain members. The following is an extract from the letter in reference to this:

Q.- Did you say, Mr. Daly, that's it, that you had drafted and the Commission had taken before you called for those hearings at all?

M. DALY: No sir, not at all. The Commission I do not believe in any way had discussed the matter in that way.

Q.- You called for those hearings on December 4th, 1934, and this is the minutes of December 22nd, 1934. (The minute referred to is that quoted previously).

A.- That was something which had occurred my attention. I did not know it was there.

Q.- That was before you called the hearings.

A.- I thought that was after.

It is difficult to understand why the Commission asked for leniency in view of the minutes of December 22nd, 1934, unless for the purpose of obtaining a short on the main point which the witnesses were saying at that time, or for the purpose of complying with the wish of the Premier. In all events, it is clear from minutes given below as the witnesses did not notice that the Commission was acting in its judicial by members. Mr. Lewis of Lewis & Duncan on being questioned this matter stated:

Q.- Did you regard this request for leniency as a mere verbal thing asking for more time?

A.- Yes ... I said "there is no use bidding on it, they do not intend to let it to a contractor".

Q.- You did not take the request for a tender seriously?

A.- No.

Q.- Your impression at that time was from what you had seen in the press, they were going to do the work themselves?

A.- Yes. Ev. 5267

Mr. Chadwick, General Manager of the Foundation Company, Limited, on being questioned on the same matter made the following statements:

Q.- Did you get the impression you did not have a ghost of a show of getting any contract on this basis or any other?

A.- I more or less got that impression, after talking with Mr. Acres. For that reason I wrote the letter as I promised him and forgot about it.

Q.- As a matter of fact, did not you and Mr. Acres and all the rest of you come to the conclusion it was pretty near a hopeless thing to get a lump sum contract on that job? Ev. 5373

A.- Oh, I think so. Yes.

Q.- Any contractor who went into that game in that period would be certain of going on the rocks in a short time?

A.- Yes, they would.

The letters of inquiry were sent out during the month of December and the contractors were requested to have their proposals submitted to the Commission by January 5th. It would have been impossible for any contractor, unless he was thoroughly conversant with the nature and magnitude of the work beforehand, to have submitted an intelligent tender in so short a time.

Q.- Yes and I said "Yours is no use sitting on it", they is not intend to let it go a contractor".

Q.- You did not know the request for a tender particularly

A.- No.

Q.- Then information at that time was from what you had been in the press, only-was only as to the main theoretical

A.- Yes.

Dr. Dr.
[illegible]

Dr. Dunstan, Senior Inspector of the Commission (Crown), sworn.

Examined on the same matter made the following statement:

Q.- Did you put the inspection you did not take a close of close of getting any measure on this large or any other

A.- I went or Clear and that inspection, after talking with Mr. Jarvis. For the first report which his letter as I promised him and larger about it.

Q.- In a matter of fact, did not you and Dr. Jarvis and all the rest of you been to the conclusion it was pretty near a hopeless thing to put a long one against on that job?

Dr. Dr.
[illegible]

A.- Oh, I think so. Yes.

Q.- Any contractor who went into have been in that position would be mentis of going on the risks in a short time?

A.- Yes, very early.

The Letters of Inquiry which were put during the month of January and the conferences were reported to have their prepaid condition to the Commission by January 5th. In which have been figurative for any instance, which is one the Commission connected with the numbers and equipment of the work particularly to have submitted an intelligent tender in so short a time.

The information requested in the invitation to tender included only the earth and rock excavation. While this portion of the work covered the major part of the expenditure, it did not take into account other very large and important parts of the work, so tenders submitted on the cost of earth and rock excavation would have afforded only incomplete information as to the ultimate cost of the whole work.

After considering the matter in all its aspects, we must come to the conclusion that the action of the Commission in calling for tenders was merely perfunctory and indicated no real intention or desire on its part to have the work done on a contract basis. This action on the part of the Commission constitutes, in our opinion, an error of judgment, and undoubtedly added substantially to the final cost of the work. Mr. Gaby in his report to the Commission under date of January 11th, 1917, uses calculations for the purpose of showing that the Commission would effect economies and eliminate contractors' profit by conducting its own work. Wisdom in such matters is gained only from long experience and, in our opinion, the Commission, lacking this experience, was quite unfitted to execute a work of such magnitude as economically as it could have been done by an experienced contractor.

No "Lump Sum" Tenders Submitted

The proposals received by the Commission in response to the letter of the Chief Engineer did not include a definite fixed tender, and they indicate that conditions at that time were so uncertain that firm prices or "lump sum" bids could not be obtained.

The firm of Baldry, Yerburgh & Hutchinson, whose proposal is most completely discussed in Mr. Gaby's report of January 11th, 1917, indicated a desire to do the work on a "cost plus" basis. Other tenderers proposed that the work be done under modified form of the same type of contract. The contractors with whom there was formal correspondence were:

The Foundation Company, Limited,
The Dominion Dredging Company, Limited,
The Dominion Construction Company, Limited,
Wm. Cowlin & Sons (Canada) Limited,
Baldry, Yerburgh & Hutchinson, Limited,
Larkin & Sangster.

Mr. Gaby in his report of January 11th, above referred to, summarizing his analysis of the estimates, states:

"After carefully considering the tenders which have been submitted by the various contractors for the carrying on of this work and allowing for present conditions and having a full knowledge of the amount of work that the engineering staff has put on the investigations, in regard to both the character of the work and the necessary equipment to handle the same, and in view of the fact that the essential staff for the organization of this work is at present employed by the Commission and it only requires the filling in of skilled labor, to handle the work with efficiency, which skilled labor we are quite confident can be obtained in sufficient quantity and quality to handle the work satisfactorily, I would, therefore, recommend that the work be undertaken by the Commission, as we have everything to gain, and from the information received from the tenders submitted, nothing to lose in so carrying on the work."

Requests not Regarded Seriously

The firm of Larkin & Sangster were asked to submit a tender, but declined to do so. It will be remembered from evidence already quoted that Mr. Larkin states that he understood, before receiving the request to tender, that the Commission would do the work itself, and this is confirmed by the Company's letter of December 30th, 1916, in which they state:

The idea of Salary, Profits & Bonuses, which proposed to cover employees directed in the Duty's report of January 11th, 1917, initiated a letter in the book as a "real plan" basis. Other tendency proposed that the only be some value multiple form of his some type of reviews. The correspondence with which there was formal correspondence were:

The Pneumatic Tyre Co., Limited,
The Dunlop Rubber Company, Limited,
The Dunlop Plantations Company, Limited,
The Sumlo & Tube Company Limited,
Malaya, Borneo & Sarawak, Limited,
Perak & Selangor.

Mr. Day in his report of January 11th, above referred to, concluding his analysis of the situation, states,

"After carefully considering the letters which have been submitted by the various directorate for the purpose of this work and allowing for present conditions and having a full knowledge of the amount of work that the engineering staff has put on the investigations, in regard to both the character of the work and the necessary equipment to handle the same, and in view of the fact that the essential staff for the organisation of this work is at present employed by the Munitions and it only remains the filling in of skilled labor, to handle the work with efficiency, with skilled labor as can quite possibly be obtained in sufficient quantity and quality to handle the work satisfactorily, I could, therefore, recommend that the work be undertaken by the Department, as we have everything in gear, and from the information received from the various companies, waiting to join in as soonpiece in the world."

Benefits and Deferred Interests

The firm of Lambie & Langdon were asked to submit a bonus, but declined to do so. It will be remembered from evidence already quoted that Mr. Lambie stated that he considered, before realizing the results to bonus, that the Commission would do the work itself, and this is confirmed by the Company's letter of December 28th, 1918, in which they state:-

Larkin did not contradict this in his testimony (?)

"We may say that we understood that the Commission intended to undertake this work itself, and as this was so obviously the proper course to take under existing circumstances, your inquiry was somewhat unexpected."

Again:

"As regards economy, your decision to use electric power is well advised, in view of the price at which you will be able to obtain it, and a very great saving in construction cost should result.

"To insure speed it will be absolutely necessary to use new electrically driven plant of the newest, heaviest and most up-to-date type that money can buy. We do not know of any contracting firm on this continent which can meet the above requirements or which could meet them by the purchase of new plant of the requisite type inside of one year or eighteen months."

(4) This was true, it was a reason for the action

As already shown, the company did not regard the request from the Commission seriously, so it is not unnatural that a letter along these lines should be written. To write such a letter was good policy, for instance the last paragraph:

(See Here parts)

"We have taken the liberty of expressing our opinion at some length; first, because we have watched the development of this project through its preliminary stages with great interest and have given it considerable thought; and second, because we have a desire to have clearly understood our reasons for not submitting a tender, as we do not wish to prejudice our standing with the Commission in connection with future work which may be carried out under normal conditions, and which we may be better able to handle."

In other words, Messrs. Larkin & Sangster, aware of the futility of submitting a tender, paid tribute to the judgment of those who made it futile, so that future business relations might not be imperilled.

(1)

NLD

Secretary

"We can say that we understand that the Commission intended to underline this issue itself, and we felt we should be people ready to take major existing circumstances, such as policy war economic cooperation."

Again,

"We recently mentioned, your questions on the electric power in this activity, in view of the price at which you will be able to obtain it, that is very great energy in operations such should result.

"We believe equal it will be absolutely necessary to use one electricity before plans of the company, involved and that up-to-date type also being one day. We do not know of any activities from an this committee which can meet the above requirements or which could work time by the produce of one plant or the be-ginning type inside of one year or eighteen months."

As already shown, the company did not regard the request from the Commission seriously, as it was mentioned that a letter "long than usual as written." To write such a letter was good policy, for in-stance the last paragraph:

"We have taken the liberty of expressing our opinion on some length: first, because we have welcomed the development of this project through the preliminary stages with great interest and have given it wholeheartedly cooperation, because we have a desire to have closely associated our business for the activities a better, or we do not wish to prejudice our standing with the Commission in connection with future work which may be carried out under normal conditions, and which we may be under this in mind."

In other words, Ewers, with a Commission, aware of the difficulty of establishing income, put curbs on the project at times we feel it fitting, on that where Watson principles did not be important.

Government Work Costs More

We will deal later with the decision of the Commission as to the type of equipment used on the work, but its desire to employ electrically driven plant of large capacity did not in any way prevent the employment of an experienced contractor on the work. Many cases may be cited where contracting organizations have been employed to carry on construction work, with the owner supplying all or part of the equipment required. Undoubtedly the Commission would have experienced great difficulty in getting any contractor to purchase at his own risk the type of equipment used, not because he is incapable of using plant of special type, but because a contractor must necessarily figure upon the ultimate utility of any equipment which he uses on his work, and cannot afford, unless properly protected, to purchase plant which he will be unable to use in the future in the ordinary course of his business, or dispose of advantageously.

The market for both labour and material was at this time in a very unstable condition; wages had been increased and labour was unsettled. The general contractor, even in normal times, has to cope with such conditions, and was undoubtedly in the best position to deal with a situation such as existed in 1917, and the following years. Even under ordinary conditions there is a disposition on the part of labour when working on a Government job to regard it as an opportunity for drawing much pay for little work.

In our opinion, notwithstanding the decision of the Commission with regard to the type of equipment to be used on the work, it should have employed a reputable contracting organization to direct the opera-

tions and control the labour.

It is to be remembered that at the time the Commission made the decision to do the work itself, it had in mind only the definite problem of constructing a development finally capable of producing 300,000 horse-power, with an immediate installation of 100,000 horse-power. Therefore, while it would have been impossible to get a firm bid for doing the work from any contractor, by reason of the uncertain conditions then existing, there is no doubt in our minds that a reputable construction organization would have been glad to undertake the work, using the type of equipment selected by the Commission, guaranteeing unit prices on a sliding scale of wage rates and adjustable prices with respect to material.

The argument may be advanced that, while the Commission's decision to do the work without employing a contractor was wrong under the conditions existing then, its decision was fully justified in the light of subsequent events, such as the tremendous increase in labour and material costs, the decision to employ night shifts and rush schedules, and especially because of the changes in design that were made.

We have already answered such argument in part and will deal more fully with the general question of management in a later section of this report. It is sufficient at this place to point out that, in our opinion, some construction organization should have been engaged on some modified form of the "cost plus" contract to execute this work, and that had this been done, the work would have been conducted along much more efficient lines than it was. A contracting organization in addition to

reputations were not at stake in 1917-18

capacity & efficiency were important factors but this statement is of small necessity

being thoroughly experienced in work of this character, would have had its reputation at stake and would have made every effort to keep the costs within reasonable limits.

It is impossible to say what saving would have been made had such a procedure been followed, but, in our opinion, it would have been a substantial one. There is little doubt that labour troubles on the work would have been reduced, and the efficiency and morale of the men maintained at a higher level, had the work been under independent control. This opinion does not necessarily imply a criticism of the technical qualifications of the men who were in charge of the work, for as managers of the construction they were hampered by difficulties inseparable from the method chosen by the Commission for doing the work.

In giving evidence before us the engineers of the Commission have stated that everything was done to place the management of the work on the same basis as it would have been had a contractor been employed; they state that it was in the hands of those of the staff who were well-qualified and had long experience in construction work, and that they employed as a general superintendent a man whose whole experience had been gained in the service of contractors. We will deal with these statements in another section of this report.

We will deal in detail with labour inefficiency, wage rate increases, strikes and other matters later in this report, and at this point only mention in passing that the period of inefficiency apparently lasted longer on this than on other work. The period during which the peak of

being thoroughly experienced in work of this character, would have had difficulties as stated and would have made every effort to keep the costs within reasonable limits.

It is impossible for any dual working model to have been made and a precise case claimed. But, in our opinion, it would not be a substantial one. There is little doubt that labour difficulties on the case would have ensued, and the attendant and results in the one situation at a higher level, but the work also under independent control. This opinion has not necessarily implied a criticism of the professional ability of the men who were in charge of the work, but as members of the administration they were responsible for eliminating unnecessary time and costs by the exercise of better supervision.

In giving evidence before the Commission of the Investigation Board stated that everything was done to give the management of the work on the site basis as it would have been had a contractor been employed. They state that it was in the hands or knowledge of the chief who were qualified and had long experience in construction work, and that they employed as a general superintendent a man whose work supervisor had been placed in the service of contractors. We will deal with these statements in greater detail at this report.

In this and in conjunction with former inquiries, we find in-stances, firstly and other instances dealt in this report, and at this point only remains to quote that the period of construction originally intended longer in this than on other work. The period during which the peak of

wage increase lasted was also longer than it generally lasted elsewhere. The peak of labour prices throughout the country began to decrease from the beginning of the year, 1920. In respect to the Queenston-Chippawa Power Development, Mr. Francis submits a chart on pages M-5 and M-5a of his report which shows that wage rates on the Development did not commence to decline until August, 1921, so that the Commission either did not or was unable to reduce the rates in accordance with the general practice at that time. In a chart submitted to our Consulting Engineer by Messrs. Fraser, Brace, Limited, this Company shows that its construction costs reached their absolute maximum during the year 1920 and that a decrease took place from the commencement of 1921. Figures obtained from the Engineering News-Record show that the peak of costs was reached during mid-summer of 1920 and that before the end of 1921 very substantial reductions had taken place bringing the costs down to those obtaining at the end of 1916.

Wage Increases and Inefficiency Last Longer

It is well known that as soon as wages decreased, an increase in efficiency was observed. The Commission's engineers claim, however, that inefficiency increased continually until mid-summer of 1921, and that it was not until July or August that any improvement in this respect was observed. That this change in the attitude of the men employed on the Queenston-Chippawa Development should lag behind the change elsewhere is not unnatural, the intimate relation between contractor and workmen was absent and the men undoubtedly felt that, as they were working for the Government, they were in a more secure position than those who were employed under private control.

Section 36

ESTIMATE NO. 1

Adequacy of Estimates

The adequacy of an estimate depends upon many factors, but principally upon the accuracy of the unit prices and quantities used. The former must be adequate for the type and amount of work contemplated, and the latter must be correct. Inaccuracy in either results in an inaccurate estimate.

The accuracy of the unit prices in turn depends upon the correctness of the basic assumptions made. It is of first importance on a job of this character that the proper equipment be selected and that its output capacity per working day be known within close limits. Again nearly every undertaking has a part on the completion of which by a certain time largely depends the success of the whole, and such a governing part must be studied in relation to the working schedule and to seasonal conditions.

We have discussed up to this point conditions which may be described as controllable. It is true that in all construction work unknown factors exist over which the contractor has no control and it is usual, therefore, to provide an adequate sum in an estimate to cover contingencies. Such an item also provides for the labour troubles generally encountered on work of any magnitude and a reasonable margin for fluctuation in material costs. These items cannot be classed as controllable items, but are always provided for according to the experience and knowledge of the estimator. In

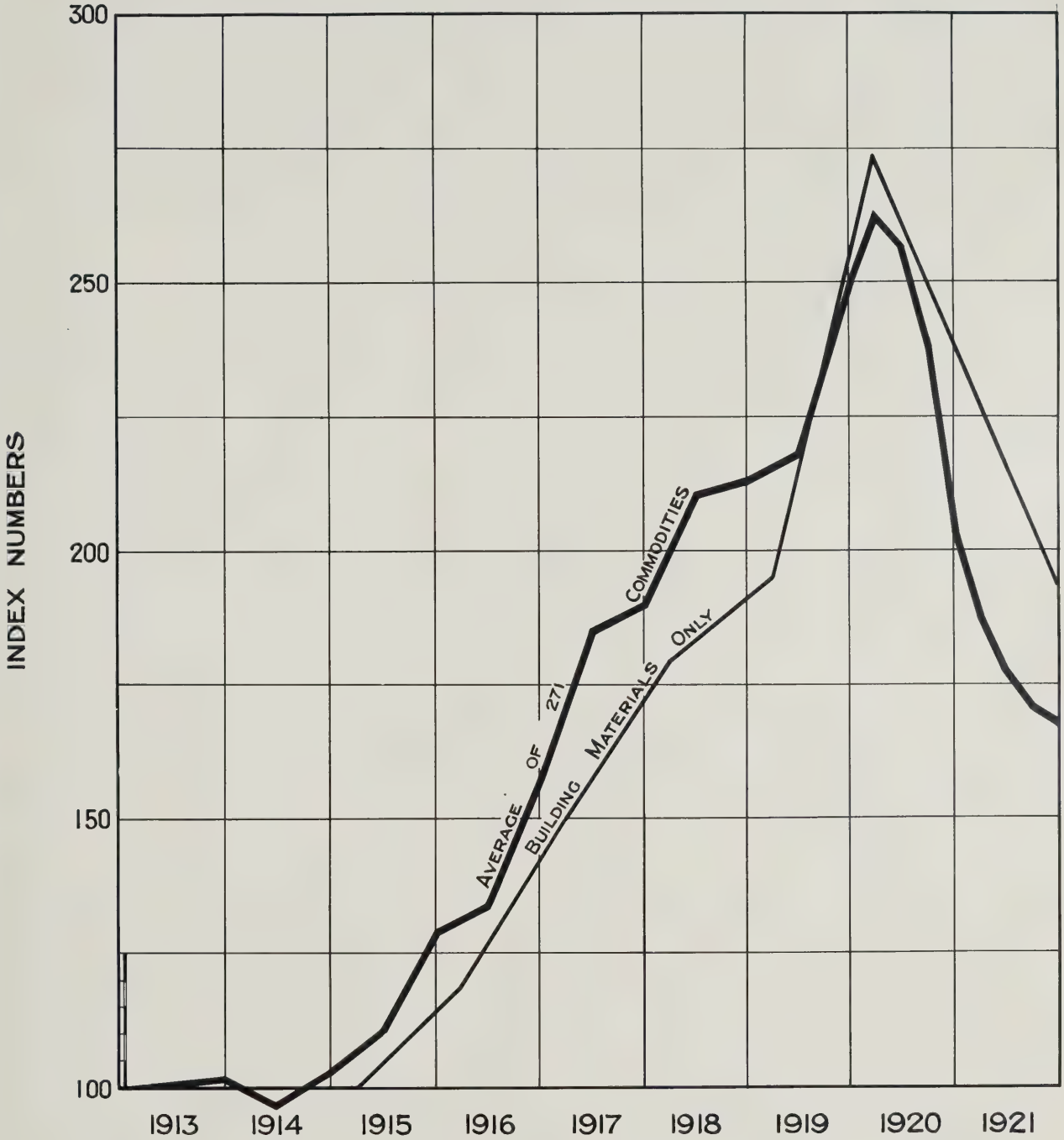
addition there are items which are entirely beyond control, such as abnormal wage increases, unusual labour shortage and resulting decrease in efficiency, and abnormal increases in material costs.

For several years prior to the beginning of the war in 1914, labour and material costs had been practically steady, and any slight upward or downward trend had been gradual. It was, therefore, comparatively simple to foresee within reasonable limits the conditions which would obtain generally on construction work.

War-time Conditions

For a period after the war had commenced there was no noticeable stringency in the labour market, nor did the prices of materials rise. In the first half of 1915, the cost of building materials began to increase. Labour rates also showed an upward tendency, and conditions generally became uncertain. For purposes of reference we are including herewith as pages 243 and 244 charts prepared by our Consulting Engineer which illustrate conditions that obtained during the period 1913 to 1921, in territory comparable as nearly as may be with the Niagara district in general.

The first of these charts on page 243 shows that a sharp advance in building materials commenced at the end of the first quarter of 1915, and continued to rise with uniform rapidity until the early part of 1919. From then until the early part of 1920 the rate of increase was accelerated, and thereafter a very rapid decline took place.

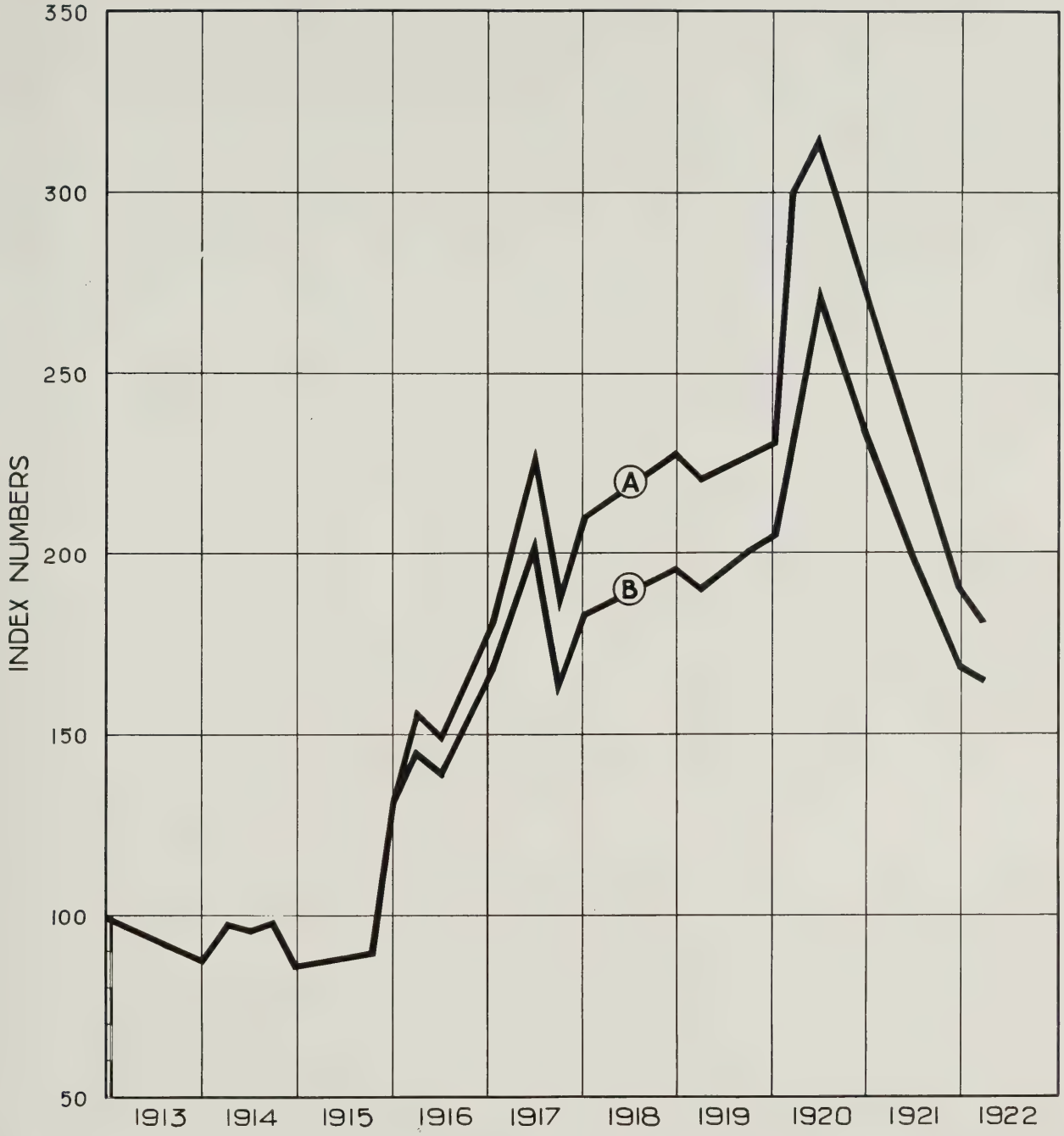


Note:
Chart Based on The Labour Gazette, April 1922.

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
QUEENSTON-CHIPPAWA POWER DEVELOPMENT

WHOLESALE PRICE INDEX NUMBERS BASED ON THE LABOUR GAZETTE

Toronto, July 27th, 1923. Made by GEB., Checked by L.S.H.
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS



A – Deduced from Construction Cost Index Numbers from Engineering News-Record of Jan. 5th. 1922 and a Labour Efficiency of 100% in 1913 and 60% in 1920

B – Deduced from Construction Cost Index Numbers from Enginering News-Record of Jan. 5th. 1922

Hydro-Electric Inquiry Commission
W. D. Gregory, Chairman
Queenston-Chippawa Power Development

COST INDEX NUMBERS BASED ON ENGINEERING NEWS-RECORD

Toronto, July 27th, 1923. Made by [illegible] Checked by [illegible]

Walter J. Francis & Company
Consulting Engineers

The second chart on page 244 indicates the general tendency of construction costs, indicating a very rapid rise from the latter part of 1915 until the middle of 1917. Conditions from that time until 1920 showed various fluctuations, but remained reasonably constant. During the first six months of 1920, another rapid increase took place, but thereafter a sharp decline occurred bringing costs at the end of 1921 down to approximately those obtaining at the end of 1918. WJF. M-36

We also include herewith as page 246 a chart prepared by our Consulting Engineer relative to wage increases during the period 1913 to 1921. These figures are based upon statistics compiled by the Department of Labour and show that conditions remained fairly constant until 1915. From then on, in harmony with the increase in cost of commodities, the curve rises rapidly, reaching a peak in the beginning of 1920 and declining sharply during 1920. WJF. M-7

On page 247 we include a chart prepared by Messrs. Fraser, Brace, Limited, of Montreal, one of the large construction companies engaged in hydro-electric development work in Canada. Their experience during the period under discussion was relatively the same as that indicated by the diagrams discussed, though the chart varies to a certain extent in that it shows a 10% increase in cost for 1913 to 1915. WJF. M-38

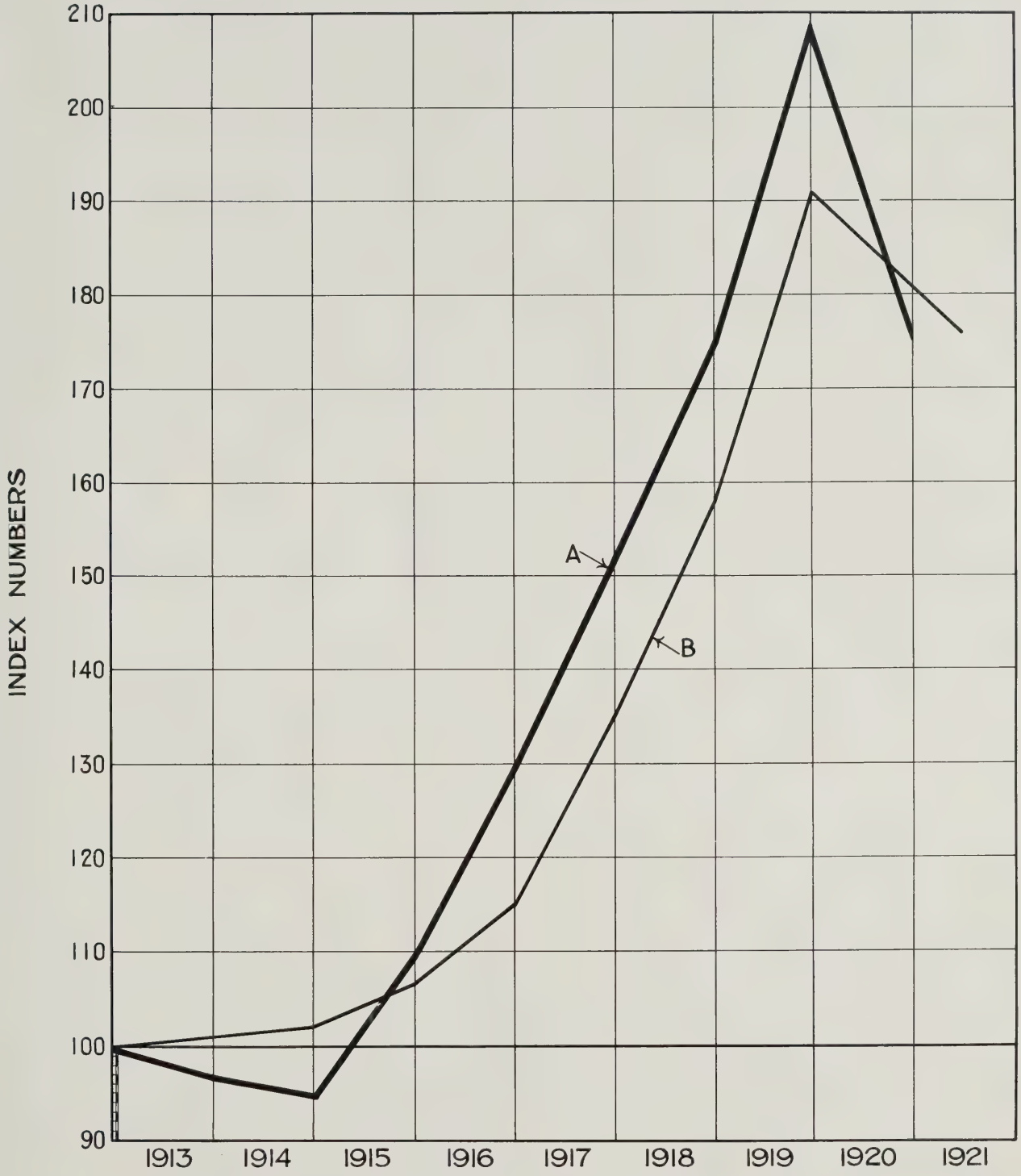
From this point onward, however, the costs increase more rapidly until the end of 1917, and then the growth becomes very rapid reaching its peak during 1920. From the beginning of 1921 a sharp decline takes place and by the end of 1922, the diagram shows that costs had returned to approximately the conditions prevailing at the end of 1918.

The second chart on page 344 indicates the general tendency of unemployment during, indicating a very rapid rise from the latter part of 1929 until the middle of 1931. Conditions then show some small 1930 showed various fluctuations, but remained reasonably constant. During the first six months of 1936, another rapid increase took place, but thereafter a sharp similar movement tending back to the end of 1931 does in approximately time extending at the end of 1936.

We also include herewith on page 360 a chart prepared by our Commission Employer relative to wage increases during the period 1919 to 1931. These figures are based upon statistics compiled by the Department of Labor and show that conditions remained fairly constant until 1929. From 1929, then on, in harmony with the decrease in rate of unemployment, the wage rates rapidly, reaching a peak in the beginning of 1930 and declining sharply during 1931.

On page 347 we include a chart prepared by Harvey Jones, Jones, Limited, of Montreal, one of the large manufacturing companies engaged in hydro-electric development work in Canada. Their experience during the period under discussion was relatively the same as that indicated by the diagram discussed, though the chart varies to a certain extent in that it shows a 10% increase in rate for 1931 to 1932.

From this point onward, however, the rates increase more rapidly until the end of 1937, and then the trend becomes very rapid reaching its peak during 1938. From the beginning of 1931 a sharp decline takes place and by the end of 1932, the diagram shows that rates had returned to approximately the conditions prevailing at the end of 1928.



A – Common Labour; Based on Statistics of Common Labour in Factories and Camps.

B – Composite Curve giving Wage Rates for Twenty-one Classes from Thirteen Canadian Cities.

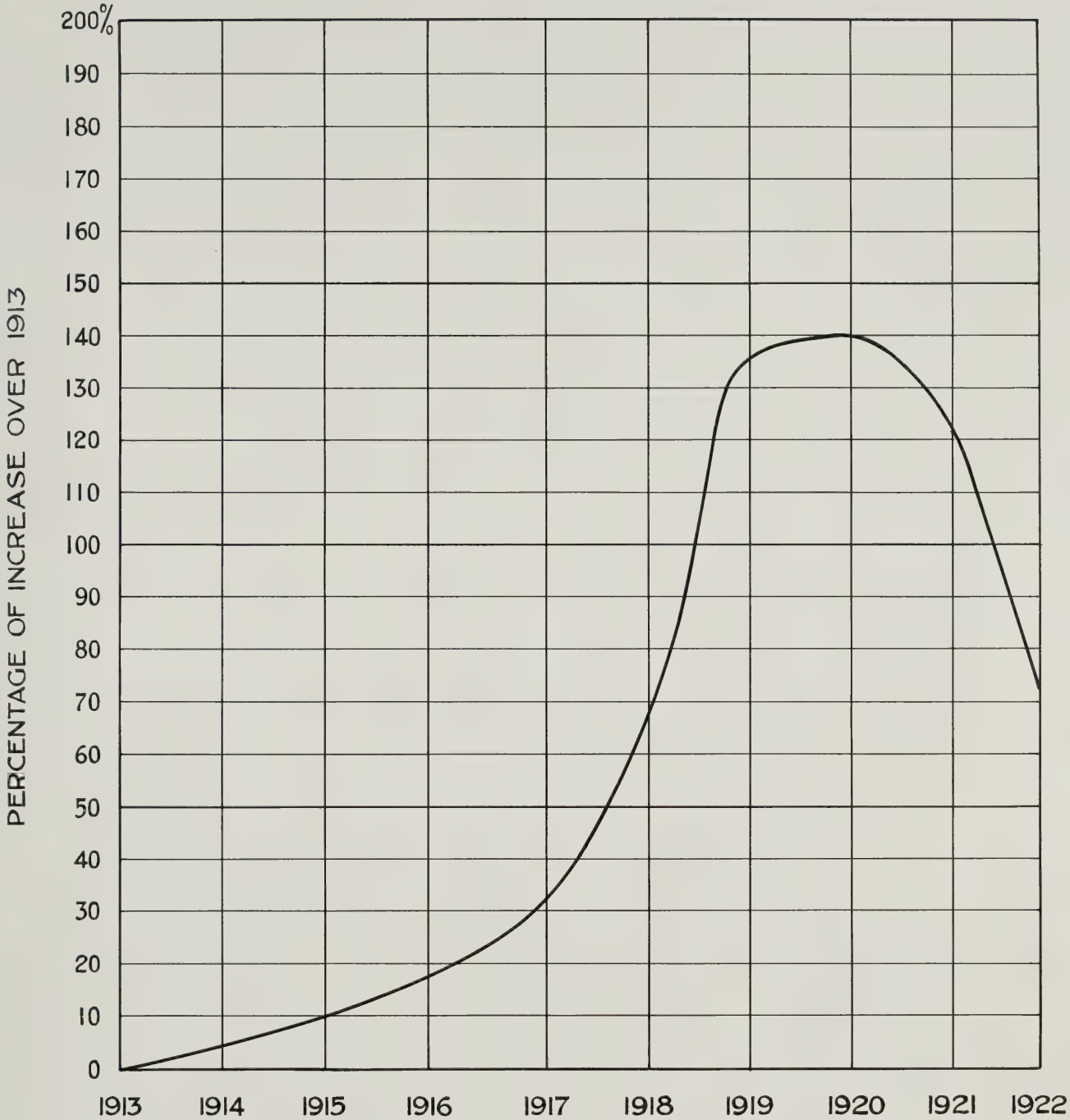
Note: Chart compiled from Report №3, 1922, Department of Labour.

Hydro-Electric Inquiry Commission
W. D. Gregory, Chairman
Queenston-Chippawa Power Development

CURVES OF WAGE RATE INDEX NUMBERS BASED ON DEPARTMENT OF LABOUR

Toronto, July 27th, 1923. Made by G.E.B., Checked by L.J.H.

Walter J. Francis & Company
Consulting Engineers



NOTE:
THE ABOVE CURVE IS PLOTTED FROM DATA FURNISHED BY FRASER, BRACE, LIMITED, FROM THEIR RECORDS OF THE FOLLOWING WORKS:
CEDARS RAPIDS DEVELOPMENT, ST. LAWRENCE
GOUIN DAM, ST. MAURICE
BIG EDDY DAM, SPANISH RIVER
(FOR INTERNATIONAL NICKEL COMPANY OF CANADA LIMITED)
CHUTE AUX GALETS DEVELOPMENT, SHIPSHAW RIVER
(FOR PRICE BROTHERS & CO., LIMITED)
GREAT FALLS DEVELOPMENT, WINNIPEG RIVER
(FOR MANITOBA POWER COMPANY LIMITED)

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

PERCENTAGE OF INCREASE OF CONSTRUCTION COSTS FRASER, BRACE, LIMITED

Toronto, July 27th, 1923. Made by GEB. Checked by W.D.A.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Immediately conditions became unsettled, those contractors who had been in the habit of doing their work under "firm bids" refused to accept work unless on a "cost plus" basis or some other modified form of contract, which would protect them in the event of further increases in labour and material costs. Their decision in this respect was not on account of the increased cost prevailing at the time estimates were prepared by them but on account of the uncertainty of future conditions indicated by the increases that had then occurred. This attitude on the part of contractors was more evident in respect to work of long duration and great magnitude. Contractors could be found during the entire war and post-war periods who would give firm prices on work of small extent which could be done in a short time, but no firm tenders could be obtained on work which would be spread over a period of years.

Records show that many large construction projects under way at that time were entirely closed down on account of increased costs. Work in immediate prospect was abandoned, or if absolutely necessary carried out under some modified form of contract. Much work was carried out on the straight "cost plus" basis and other work conducted in a manner which would protect the contractor in case of increase in labour and material costs. There are many examples of work in which the contractor estimated the cost on assumed labour and material prices, and the contract provided for increases in the cost proportionate to increases occurring in labour rates and cost of material. It may be generally stated, however, that with conditions unsettled as they were, any construction work that had to be

OK

Immediately conditions became unsettled, there unfortunately was not been in the basis of doing that: and make "film sides" relaxed in energy work taking on a "free plane" basis or some other modified form of industry, which would produce films in the event of further increases in labour and material costs. Their decision in this respect was not on account of the increased wage prevailing at the time conditions were prepared by them but on account of the uncertainty of future conditions indicated by the increases that had been announced. This attitude on the part of exhibitors was more evident in regard to long duration and great magnitude. Publicity was said to flood during the making war and peacetime products who would give film prices on work of small amount which would be done in a short time, but the film industry would be divided on what action would be carried over a period of years.

Records show that many large construction projects under way at that time were entirely closed down on account of increased costs. Work in industrial premises was abandoned, or if absolutely necessary marked not under some modified form of contract. Such work was carried out in the straight "cost plus" basis and other work undertaken in a manner which would produce the maximum in case of increase in labour and material costs. There are many examples of work in which the successful estimators the last on account labour and material prices, had the contract awarded for in excess in the cost appropriation to increase everything in labour costs and cost of material. It may be generally stated, however, that with conditions varying in that very, any contractor was that had to be

undertaken by railway companies, industrial and other large concerns was still placed according to customary procedure in the hands of reputable contracting organizations, for there still existed the believe that a reasonable profit paid to a good contractor was more than offset by the benefits received in return.

This has always been a controlling question in my mind.

Under the part of this report entitled "Estimates and Appropriations", we have shown that Estimate No. 1, bearing date June 23rd, 1915, prepared by the engineers of the Commission, formed the basis of the first report to the Premier by the Chairman of the Commission bearing date September 13th, 1915. This estimate in the amount of $10,500,000 for certain works and with a 100,000 horse-power installation was based upon underlying details of which the unit prices used formed a most important part. It is impossible in this report to deal in detail with every item of work entering into the estimate, so we will generally confine our remarks to prices used in reference to the bulk of the work, namely, rock and earth excavation in the canal. A complete analysis of this and all other estimates is given in "Chapter K - Costs, Analysis of Estimates, Part I and Part II", prepared by our Consulting Engineer.

On examining this estimate we find that for the items above referred to, namely, rock and earth excavation, the unit prices used were $1.00 and 30¢ per cubic yard, respectively. Disregarding for a moment indications existing at that time as to the uncertainty of the labour and material market, and regarding the unit costs used only as they apply to pre-war conditions, those unit prices for estimating purposes were, in our opinion, too low.

While the quantity of material to be moved was very great, there were other conditions tending to offset this advantage. The canal

proper has a total length of about 8-3/4 miles, the average depth being about 80 feet and its greatest depth just north of Lundys Lane is approximately 140 feet below the general ground level at that point. This great depth of excavation, together with the fact that the "spoil" had to be hauled considerable distances for disposal purposes, tended to increase the cost of the excavation above that ordinarily encountered.

The above remarks in reference to the unit costs used for earth and rock excavation apply generally to the other items of work estimated upon, and, in our opinion, it is doubtful if the actual costs could ever have been so low as the estimated costs.

Government Misinformed

The report by the Chairman of September 13th, 1915, undoubtedly led the Government to believe that the Commission had a full and complete knowledge of all conditions, for the letter states:

> "Careful surveys have been made of this Queenston-Chippawa scheme of development with detailed explorations of earth and rock strata and other engineering data necessary to enable estimates to be prepared of the cost of the development."

Mr. Gaby, in his report of June 23rd, 1915, on which the Chairman of the Commission apparently based his report to the Prime Minister, is somewhat more conservative when he states:

> "I have carefully investigated the power conditions on the Niagara Peninsula, and am pleased to submit a preliminary estimate covering the development of 100,000 h.p. at the Queenston site."

proper has a total length of about 8-3/4 miles, the average depth being about 20 feet and its greatest depth just south of Dunlap's Island is approximately 150 feet below the general common level of that point. This great depth of water, together with the fact that the "equilibrium" has to be taken considerable distances for disposal purposes, tended to increase the cost of the generating stage that originally contemplated.

The above remarks in reference to the total costs need for water and site acquisition apply generally to the other items of work originally open, and, in our opinion, it is doubtful if the actual costs could ever have been so low as the estimated costs.

Financial Statement

The report by the Chairman of September 1911, indicates, undoubtedly that the Government is failing the Commission but a full and complete knowledge of all conditions, for the latter states:

> "Careful surveys have been made of this Generating-Station, also of development with detailed explorations of such and road ways and other engineering data necessary to establish estimates to be presented at the next of the Legislature."

Mr. Tait, in his report of June 1911, on which the Commission of the Commission apparently based his report to the Prime Minister, is somewhat more conservative when he states:

> "I have carefully investigated the power conditions on the Niagara Peninsula, and am pleased to submit a preliminary estimate covering the development of 100,000 h.p. at the Queenston site."

It would appear from the evidence given by Mr. Acres before us that the statement of Mr. Gaby that the estimate was of preliminary character is more correct than the statement contained in the Chairman's letter to the Government. Questioned as to what plans had been made prior to Estimate No. 2, Mr. Acres says:

Q.- Well, what plans have you that were prepared on this work prior to the plans of January 7th, 1917?

A.- Well, I cannot tell from memory very precisely, but there are certainly plans in existence.

Q.- A complete set of plans of the work?

A.- I would not go so far as to say they were complete plans, because the proposition was in a state of flux at that time, but they were plans indicating our line of thought at that time. Ev. 4177

Mr. Acres' statements show that the work was still in a state of evolution when Estimate No. 1 was prepared and it, therefore, cannot be regarded as the definite and reliable estimate it was indicated to be in the report of the Chairman to the Government.

Estimate No. 1 was again used as a basis of representation to the Government in January, 1917. Details of the communication at that time are given in the part of this report dealing with "Estimates and Appropriations". As noted therein, the Commission in January, 1917, was still using as a basis the unit costs contained in the Chief Engineer's report dated June 23rd, 1915, and firmly maintained that, while the cost of labour and material had advanced and the cost would probably increase 15% to a possible extreme maximum of 20%, the 25% allowance for engineering contingencies would absorb the greater portion of the advance.

It would appear from the evidence given by Mr. Aaron Bowman as that the statement of Mr. Tobey that the material was of questionable character is more correct than the statement contained in Mr. Ickes's letter to the Secretary. Questioned as to what plans had been made prior to Saturday Feb. 10, Mr. Bowman says:

Q.- Well, what plans have you that were prepared on daily work prior to the plans of January 7th, 1937?

A.- Well, I cannot tell from memory very precisely, but there are certainly plans in existence.

Q.- A complete set of plans of the work?

A.- I would not go so far as to say they were complete plans, because the preparation was in a state of flux at that time, but they were plans indicating the lay-out of houses at that time.

Mr. Aaron' statements show that the work was still in a state of evolution when Saturday Mr. I was prepared and it, therefore, cannot be regarded as the definite and publicly intended it was intended to be the report of the Children's Bureau.

Saturday Mr. I was again asked as a basis of representation to the Government in January, 1937. Details of the consultation at that time are given in the part of this report dealing with "Children and Appropriations". As noted therein, the Conference in January 1937, was still using as a basis the work made contained in the Chief Engineer's report dated June 22nd, 1936, and firmly maintained that, within the area of income and material and structure and the more would probably increase 20% in a year this actual maximum of 10%, the 10% allowance for engineering contingencies would cover the greater portion of the increase.

By referring to the charts showing the general tendency of costs at that time, it must be concluded that the Commission either did not realise or disregarded the extent to which labour and material costs had increased, and the necessity of providing for further increases which must then have appeared inevitable.

As already shown, the Commission on September 13th, 1915, submitted to the Government as the cost for the installation of 100,000 horsepower, a figure of $10,500,000, which was based upon an estimate signed by Mr. Gaby bearing date June 23rd, 1915. The report referred to indicates that the problem had received study as far back as 1913, and the Chairman's letter in part states as follows:

> "Careful surveys have been made of this Queenston-Chippawa scheme of development with detailed explorations of earth and rock strata, and other engineering data necessary to enable estimates to be prepared of the cost of the development."

It will be noted, therefore, that the Government had every reason to believe that the estimate then submitted was the result of careful investigation and truly represented the cost that would be incurred for the work then under consideration.

Contractors' Estimates Higher Than Commission's

We have already described in detail how, in December, 1916, after the Commission had decided to carry on the work with its own organization, the Chief Engineer of the Commission requested certain firms to

By referring to the charts showing the seasonal incidence of work at that time, it must be concluded that the Commission either did not realize or disregarded the extent to which labour and material costs had increased, and the necessity of providing for future increases which may then have occurred inevitably.

As already known, the Commission on December 12th, 1919, submitted to the Government as the cost for the installation of 300,000 horsepower, a figure of $20,000,000, which was based upon an estimate signed by Mr. Guy Bearing date June 22nd, 1919. The report proceeds to indicate that the written but unsatisfactory study on the book is 1919, and the Commission's letter in part states:

> "Careful surveys have been made of this Lower-Slocan-Kootenay scheme of development with detailed investigations of water and rock strata, and other engineering data necessary to enable estimates to be prepared of the cost of the development."

It will be noted, therefore, that the Government had every reason to believe that the estimate then submitted was the result of careful investigation and truly represented the cost that would be incurred for the work than under consideration.

Engineering Estimates Under Some Conditions:

In June already discussed in detail here, in December, 1919, after the Commission had decided to proceed on the work with its own organization, the Chief Engineer of the Commission reported certain facts to

submit tenders on the earth and rock excavation in December, 1916, after the Commission had decided to carry on the work with its own organization and how, as a result of his action, on January 11th, 1917, he submitted to the Chairman of the Commission a memorandum dealing with the tenders that had been received. The only tender he dealt with in any extensive detail is that received from Baldry, Yerburgh & Hutchinson. In analyzing the proposal submitted by this firm, Mr. Gaby states as follows:

> "On the basis of comparative unit costs, the earth would cost about 35¢ per yard, and the rock about $1.60 per yard under the Hutchinson proposal, as against 30¢ for earth and $1.00 for rock under the Commission's scheme."

From this statement it is apparent that, in the opinion of experienced contractors at that time, the estimated unit costs should have been considerably higher than those used by the Commission in its estimate. Even taking into account the profit which was included in the contractors' price, 7% on actual cost, the unit prices referred to by Mr. Gaby were considerably higher than those used by the Commission in its estimates.

A unit price of $1.00 per yard for rock excavation and 30¢ per yard for earth excavation were prices which had prevailed in pre-war times on large railway contracts of an ordinary and not a special nature. In our opinion, with conditions prevailing as they were in 1916, unit prices used by the Commission were entirely too low and we would place the unit prices referred to by Mr. Gaby

as applying to the tender of Baldry, Yerburgh & Hutchinson as an absolute minimum applicable at that time. In addition to this, having regard to the uncertainty of future conditions in respect of labour and material, a substantial margin should have been allowed over and above units which may at that time have been considered as an actual cost.

Generally the same reasoning applies to other unit costs used by the Commission in respect of concrete, dredging and other items of work and, in our opinion, the estimate of $10,500,000 was much too low.

Section 39

ESTIMATES NOS. 2, 2-A AND 2-B

While a discussion and analysis of Estimate No. 1 is essential to make this report complete, the estimate was never used in connection with the work as actually constructed. It was used, however, for advising the Government when the scheme was first proposed, and later the unit prices on which it was based, particularly those for the earth and rock excavation, were compared with the unit prices used in Estimate No. 2.

Estimate No. 2 and the subsequent revisions of it were in official use by the Commission until the time that Mr. Hugh L. Cooper and later Messrs. Stuart and Kerbaugh commenced their investigations in 1920. Since Estimate No. 2 and its revisions were the last estimates prepared by the engineers of the Commission, it follows that the figures used in Estimate No. 2 must be used as our basis for determining the reasons for increases in the cost.

In making our analysis we have always kept in mind two things: first, that there have been expenditures of a character which may be described as uncontrollable ones, and second, that there have been expenditures resulting from a variety of causes, principally, in our opinion, misdirection which we refer to as controllable expenditures. Under the heading of uncontrollable expenditures are items the cost of which, we believe, would have been considerably reduced had a proper conception of their importance existed before the work was commenced, but as these items represent work on which the expenditure of a certain amount of money was necessary, our allowances in respect of them have been liberal.

The second class of expenditures, namely those described as controllable, represent expenditures which could have been entirely avoided had the work been conducted on a more systematic basis, and if due regard had been given to the basic and controlling features of the work as it proceeded.

The conclusions we have arrived at with respect to these expenditures are not based solely on the conditions existing on the work at its commencement. We have made a fair allowance for the unusual character of the work, and the manner of its performance for the first two years,- the years during which the Commission had an opportunity to learn from actual experience what results they could expect. As an indication of the form that our analysis will take we submit hereunder headings against which the excess costs will be charged:

Uncontrollable Expenditures

Changes in design
Increases in quantities
Justifiable abnormal expense
Unit costs underestimated
Fires, strikes, etc.

Controllable Expenditures

Abnormal costs, resulting from improper management, etc.

What is meant by "improper management"? Is it a fault of the engineers?

It is a difficult task to account for expenditures on construction work after the work has been completed. Especially is this the case in respect to the Queenston-Chippawa Development, for its construction was carried on during the war and post-war period when conditions were abnormal and without precedent. In making our analysis we have had definitely in mind the fact that it is easy to be wise after the event, and if we have erred in our analysis it is on the side of leniency towards the Commission, for we know that the Commission, in constructing this large work when it did, was faced with a very difficult problem.

Estimate No. 2

As heretofore noted, work was commenced and the next estimate of importance submitted to the Government is that known as Estimate No. 2. This estimate bears date December 26th, 1917, and in the meantime the engineers of the Commission had been detailed to visit other construction work being carried on in the United States. The results of their investigations were presented in the form of a report entitled "Report on Excavation Methods and Equipment". This report bears date June 26th, 1916, and a transcription of same made by our Consulting Engineer is submitted herewith. It was

Immaterials Immaterial

Damage to beams
Damages to quantities
Partially charred sequence
Unit units unidentified
Items, entries, etc.

Irrelevant Immaterial

Personal data, resulting from
Employee complaint, etc.

It is a difficult task to assess the consequences to montrea-
lion when after the error has been employed. Usually it is the case
is proved to the Government-Employee Investigator, for its investigation was
carried on during the [illegible] period when conditions were abnormal
and without precedent. In making our analysis we have had particularly in
mind the fact that it is very to be seen after the event, and if we have
erred in our analysis it is on the side of leniency towards the complainant,
for we know that the Government, in discharging this duty as we when it
did, was faced with a very difficult problem.

Problem No. 1

In Lanzadora notes, were was necessary and the last minute
of importance submitted to the Government in this manner on Saturday No. 1.
This estimate among Last December Zero, 1957, and in the meantime the de-
mands of the Commission had been detailed to visit other provincial were
being carried on in the United States. The results of their investigations
were presented in the form of a report entitled "Report on Operation Tracks
and Equipment". This report bears Zero Zero Zero, 1958, and a investigation
of were made by our Investigator Thatcher in Montreal Barrick. It was

largely on the information obtained during these investigations that Estimate No. 2 was based. Our Consulting Engineer in his report entitled "Chapter K - Costs, Analysis of Estimates, Part II, Appendices" sets forth the details of this estimate.

In Estimate No. 2 the following statement appears:

"As regards estimates of capital cost, it is to be noted that the tremendous advance which has taken place during the period of the war in the cost of labor and material has necessitated a very material increase in all estimates made during the pre-war period.

"Fortunately, for reasons hereunder explained, this statement does not hold for the two main items of cost in connection with the scheme as a whole; namely, the cost of earth and rock excavation in the Canal." WJF. Chap.K App.III-J

Again:

"Owing to the fact that the construction plant has been purchased, and that construction work is now under way, it has recently been possible to compile an estimate of the unit cost of earth and rock excavation which is based on the actual installed cost of the construction plant, the actual existing rates for skilled and common labor, and a reasonably accurate knowledge of working conditions." WJF. Chap.K App.III-K

If the records submitted by the Commission's engineers to our Consulting Engineer are correct it would appear that the statement just quoted is somewhat misleading. From the chart on page H-131 of our Consulting Engineer's report, which indicates the work that had been completed during the period from May to December, 1917, it will be noted that this only constituted a small amount of excavation immediately adjacent

Largely on the strength of this and other investigations that relate the I.C.L. was based. The transition figures in its report entitled "Chapter 3 - Labor, Industry & Services, Part II, Appendix" have the details of this estimate.

In Estimate No. 2 the following statement appears:

"In regards estimates of capital cost, it is to be hoped that the tremendous strides made in the post period during the period of the war in the cost of labor and material has materialized a very material increase in all estimates made during the pre-war period.

"Particularly, our previous estimates suggested, with absolute cost does not hold for the two main items of cost in connection with the scheme as a whole namely, the cost of earth and rock excavation in the Canal."

Again:

"Owing to the fact that the construction plant has been purchased, and that construction work is now under way, it has recently been possible to compile an estimate of the unit cost of earth and rock excavation which is based on the actual installed cost of the construction plant, the actual outstanding rates for skilled and common labor, and a reasonably accurate knowledge of working conditions."

Chap.3 App.III-3

Chap.3 App.III-4

If the results obtained by the Commission's engineers in the Terraciling Engineer are correct, it would appear that the estimate last quoted is somewhat misleading. From the chart in Case C-2(2) of the Terraciling Engineer's report, which indicates the work that had been completed during the period from May to December, 1917, it will be seen that this only constituted a small amount of excavation immediately adjacent

to Bowman's Gully and the chart on page H-125 of his report shows that the total yardage taken out up to this time, represented probably less than 2% of the total excavation.

Referring to page H-141 it will be noted that until the end of November 1917, only two steam shovels, namely, Nos. 5 and 7 had been in operation with the exception of electric shovel No. 6 which had done a very small amount of excavation during the month of November. None of the large electric shovels had commenced operations at that time, the shovels which were in operation being shovel No. 7, a 65-ton, 2-1/2 yard Bucyrus, and shovel No. 5, a 30-ton, 7/8 yard machine.

Excavation at this point was probably the simplest and cheapest of any throughout the entire work. Bowman's Gully, the disposal area, was immediately at hand, and with only two shovels working transportation service was simple, and any water encountered in the excavation could be drained cheaply and effectively into the Gully. It is difficult to understand, therefore, how the performance of the equipment then in use, and the amount and nature of work then done, could be taken as a safe basis for an estimate.

A great deal of importance was also attached by the engineers of the Commission to the use of electrically driven equipment of large capacity as compared with the use of ordinary steam driven equipment of small capacity. The appendices to Estimate No. 2 contain a series of theoretical analyses which, on the various bases used, go to show substantial savings in the use of this type of plant. Whatever was the extra efficiency of the electrical equipment used by the Commission in carrying

on the work, there is little doubt that if they based their figures on work then executed, the engineers of the Commission made an error in judgment which resulted in the submission of estimates considerably under the cost for which the whole work could have been done at that time.

Unit Prices used in the Estimates

Dealing only with the earth and rock excavation it will be noted from observing Estimate No. 2, that, while the units used in Estimate No. 1, namely, 30¢ for earth and $1.00 for rock, were low, these were further reduced and in Estimate No. 2, we find that the units used were 27¢ per cubic yard for earth and 98¢ per cubic yard for rock. It is true that the estimate provided an item of 25 per cent. for engineering and contingencies, but this was not an unreasonable allowance inasmuch as the engineers of the Commission had not completed their studies of the work and there was every reason to believe that the cost would be increased rather than decreased by improvements and refinements in the design that were at that time under consideration.

Mr. Acres, in explaining the basis of Estimate No. 2, attached great importance to the various contracts let in connection with the Calumet-Sag Canal near Chicago, and the rock excavation for the Livingstone Channel in the Detroit River. He states that these two jobs constitute the only two contemporary pieces of work on the continent, which approach the Queenston-Chippawa Development in magnitude or were in any way analogous as regards the nature of the work and the working conditions.

The eleven contracts of the Calumet-Sag work consisted of 7,856,000 cubic yards of glacial drift or earth excavation, 1,723,000 cubic yards of rock excavation and other works such as channelling.

Comments App.13

rip-rap, concrete, roadways, bridges, etc. The following table shows the quantities of the main items for each section with the dates on which the bids were opened:

Section	Bids Opened	C.Y. Glacial Drift	C.Y.Rock	Sq. Ft. Channelling	Sq.Yds. Rip-Rap	C.Y.No.1 Concrete	
1	July 25/14	320,000	315,000	270,000	500	10,050	
2	Oct. 5/11	221,000	351,000	313,000	-	3,200	
3	Feb. 15/12	335,000	220,000	162,300	5,000	13,400	
4	Aug. 10/11	780,000	121,000	-	37,000	-	
5	May 31/12	1,070,000	141,000	-	69,000	375	
7 & 8	July 19/13	2,350,000	15,000	-	-	1,200	
9	Sep. 11/13	875,000	50,000	-	70,000	1,100	
10	Apr. 13/15	670,000	300,000	-	72,000	800	Comments
11	Mar. 12/14	780,000	85,000	-	70,000	-	App. 13.
12	May 21/14	465,000	125,000	100,000	25,000	950	Page 2.
		7,656,000	1,723,000	965,300 (sic)	348,500	31,075	

The following table shows the general average for the unit contract prices on eleven sections of the Calumet-Sag Canal for earth, rock, concrete and rip-rap:

Class of Work	Lowest Price Bid	Average of all bids	Accepted Tender
Earth	$0.309	$0.379	$0.326
Rock - channelled	0.865	0.904	0.875
Rock - unchannelled ..	0.674	0.778	0.706
Plain Concrete	5.83	7.13	6.66
Rip-Rap	0.974	1.452	1.136

Flywheel assembly, assembly, Brighton, Ohio. The following table shows the quantities of the total items for each month since the start as well as the totals were opened:

Month	Week Ending	Opened 1941	O.Y.Month	Op. Pc. Shipped	Op.Value Ship-ped	O.Y.To.I Shipped
1	Feb. 28/14	320,000	410,000	475,000	300	12,000
2	Mar. 8/14	320,000	475,000	310,000	—	2,000
3	Mar. 15/14	320,000	320,000	310,000	2,000	14,000
4	Apr. 12/14	320,000	310,000	—	27,000	—
5	Apr. 27/14	1,470,000	141,000	—	22,000	[illegible]
6	May 10/14	2,320,000	22,000	—	—	1,000
7	Mar. 17/14	470,000	22,000	—	10,000	1,000
8	Apr. 10/14	470,000	[illegible]	—	12,000	300
9	May 14/14	[illegible]	[illegible]	—	20,000	—
10	Jun. 11/14	[illegible]	[illegible]	10,000	20,000	300
		7,800,000	2,270,000	800,000 (1941)	124,000	21,000

The following table shows the general average for the six cumulative quotas in effect during 1941 the Salem-Day Shift, the night, Saturday and Sip-day:

Time period	Larger Crew Size	Average Ht.Ft Size	Average Shift
Night	[illegible]	[illegible]	[illegible]
Day — Saturday ...	[illegible]	[illegible]	[illegible]
Day — Sunday ..	[illegible]	[illegible]	[illegible]
Night Sunday	[illegible]	[illegible]	[illegible]
Sip-Day	[illegible]	[illegible]	[illegible]

Mr. Acres then, on a certain basis of analysis, compares the unit prices used by the Commission with the contract prices in force on the Calumet-Sag Canal. Dealing only with rock his analysis goes to show that the Commission's price was about 34 per cent. greater than the average of the accepted bids on the Calumet-Sag work and that the Commission's price for earth excavation was 3.5 per cent. greater than the average of the accepted bids on the Calumet-Sag contracts. In analysing the matter further and assuming that the contractor's unit prices carried a burden of 10 per cent. for contingencies and 25 per cent. for profit over bare net cost, he concludes his statement by showing that, were allowance made for these items, the 1917 unit prices for Queenston-Chippawa would have been 30 per cent. to 50 per cent. in excess of the contract figures for rock and correspondingly increased in the case of earth and plain concrete.

Now, while the yardages in the Calumet-Sag Canal and Livingstone Channel were of considerable magnitude, these jobs cannot be compared with the Queenston-Chippawa work from the standpoint of construction procedure and cost. As far as we can learn from the figures and details given in the report entitled "Excavation Methods and Equipment", the Calumet-Sag Canal work was a comparatively simple operation, compared with the Queenston-Chippawa work. The disposal areas were either immediately adjacent to the cutting being made, permitting the cheap and easy disposal of material or as in the contract being carried out by Guthrie & Company, the haul to the disposal area probably averaged less than one mile. We would refer you to photographs given on pages 4, 5, 6, 7 and 13 of the report entitled "Excava-

tion Methods and Equipment" from which one can readily grasp the comparative simplicity of the work on the Calumet-Sag Canal, compared with the work on the Queenston-Chippawa Development.

Effect of Quantities on Unit Prices

Another argument advanced for the unit prices used in Estimate No. 2 was the great yardage on the Queenston-Chippawa Development. In this connection, Mr. Acres states:

> "The average prices for rock excavation for the 11 sections (Calumet-Sag) forcibly illustrate the influence that large quantities have on prices tendered. This is shown on the curve attached hereto, and indicates the relationship between quantities involved and prices bid. This curve shows that, with all other conditions similar, the prices tendered for large yardages are in a marked degree less than where the quantities are small. This fact indicates the justification for considering the item of magnitude in assigning a unit price for the excavation of the 4,357,435 cubic yards of rock involved in the Queenston-Chippawa work under one construction administration, as against 1,723,000 cubic yards of rock under eleven separate and distinct organizations on the Calumet-Sag." Comments App. 13, Page 3.

We repeat here on page 263 the chart to which Mr. Acres refers. Analyzing this chart we find that the effect of yardage on price extends only to a certain limit and that after this limit is reached, the unit price remains practically unchanged. Therefore, if in preparing Estimate No. 2, the engineers of the Commission attached any great importance to the matter of quantity in the Queenston-Chippawa work they were entirely misled. There is an economic limit beyond which costs cannot be reduced to any material extent no matter what the quantity is, and on the Queenston-Chippawa Development this economic limit was reached at but a fractional amount of the total yardage involved, and the governing

Elsa Swinnie and Ingelgaard, Ltd. allege that the inequitable complicity of the Bank in the relationship (sic), compared with the case of the Bank-Citizens-Ingelgaard.

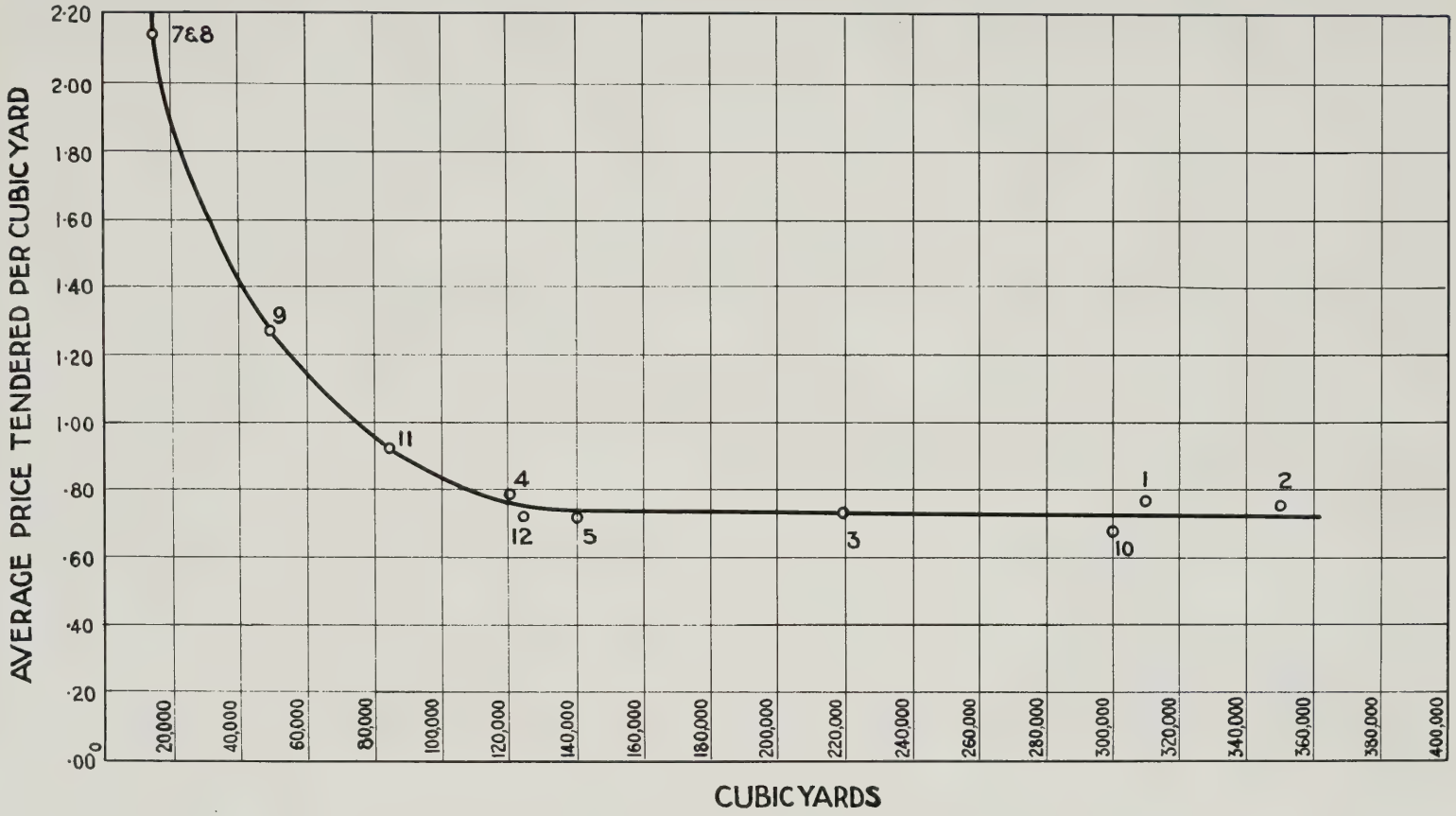
Effect of Mortality on Risk Index

Another argument advanced for the high prices used in fixing the I. was the good payday on the Swanson-Ingelgaard Proceeds. In this connection, Dr. Alvin stated:

> "The average price for one ounce in the 12 months immediately preceding the inclusion was $[illegible]. This is about on the curve estimated herein, and indicates the relationship between quantities involved and prices bid. This curve shows that, with all other conditions similar, the prices tendered for large numbers are relatively lower than those for small quantities are relatively lower. Dr. Alvin [illegible] the fact of mortality in analyzing a bid price for the creation of the 4,[illegible] pack of [illegible] [illegible] in the Swanson-Ingelgaard were under the [illegible] [illegible]. We regard 3,[illegible] as only pack of [illegible] [illegible] seven [illegible] and [illegible] [illegible] in the [illegible]."

Swanson Exp. 12, Page 5.

We repeat here on page 582 the chart to which Mr. Jones refers. Analyzing this chart we find that the effect of increase on price extends only to a certain limit and that after this limit is reached, the well price remains practically unchanged. Therefore, it is proposing Exhibit Fee I, the existence of the Commission attached any great importance to the matter of quantity in the Swanson-Ingelgaard work they were actively dialed. There is no reason that beyond which must assume be placed to any general price on return was the quantity I., and so the Swanson-Ingelgaard Investment with accounts limit was reached at but a fractional amount of the total pay-day transfer, and the preceding



APPENDIX 13-CHART A

RELATION BETWEEN QUANTITIES AND UNIT PRICES

ROCK EXCAVATION-CALUMET SAG CANAL

(AVERAGE OF BIDS ON ROCK IN EACH CONTRACT)

June, 1923.

Re-drawn by Walter J. Francis & Company, Consulting Engineers, August, 1923.

features with respect to cost such as great depth of excavation, its water saturated condition, the length of haul to the disposal areas, etc., more than offset any advantage of quantity.

Calumet-Sag Work done under Pre-war Contracts

There is another aspect with respect to the comparisons of contracts let on the Calumet-Sag Canal and this has to do with the date when these contracts were let. Referring back to the table given on page 260, we find that some of these contracts were apparently let in the years 1911, 1912, 1913 and 1914. It is true the work was still continuing in 1916, but is it reasonable to compare unit costs applicable to conditions for work carried out during 1917, 1918, 1919 and 1920 with those applying to contracts which were let as early as 1911 or 1912?

War-time Conditions Affect Construction Costs

Our Consulting Engineer has prepared and presented to this Commission a report entitled "Chapter M - Discussions", in which, among other things, he gives information relative to the costs of construction work obtaining during various years. In making these studies, he obtained from Messrs. Fraser, Brace, Limited, Contracting Engineers of Montreal, who have done a great deal of hydro-electric development construction, details of the fluctuation in construction costs during the period 1913 to 1922. This information has been plotted in the form of a chart by our Consulting Engineer and is included herewith as page 247. From this chart it will be observed that construction costs had shown an increase during the period

Factors with regard to part, with no great depth of measures, the water measured conditions, the length of road to the diversion area, etc., more than offset any advantages of quantity.

Calumet-Jar York dam under Pre-war Contracts

There is another aspect with regard to the undertaking of contracts in the Calumet-Jar Point and this has to do with the date when these contracts were let. Referring back to the table given on page 380, we find that some of these contracts were apparently let in the years 1921, 1923, 1927 and 1928. It is true the work was still continuing in 1932, but it is reasonable to suppose that such applicable to contracts for work carried out during 1929, 1930 and 1931 were those applying to contracts which were let in early as 1921 or later

COPY

Pre-War Conditions after Construction Years

The Consulting Engineer has prepared and presented to this Commission a report entitled "Chapter X - Discussion", in which, among other things, he gives information relative to the costs of construction work obtaining during various years. In making these checks, he obtained from Messrs. Fraser, Brown, Lindal, Contracting Engineers of Montreal, who have done a great deal of hydro-electric development construction, details of the fluctuations in construction costs during the period 1910 to 1928. This information has been plotted in the form of a chart by our Consulting Engineer and is included herewith on page 377. From this chart it will be observed that construction costs had shown an increase during the period

1913 to 1917, of approximately 33 per cent. It is interesting to note that the increase during 1917 had been more rapid than in previous years, thus indicating to some extent the conditions to be expected.

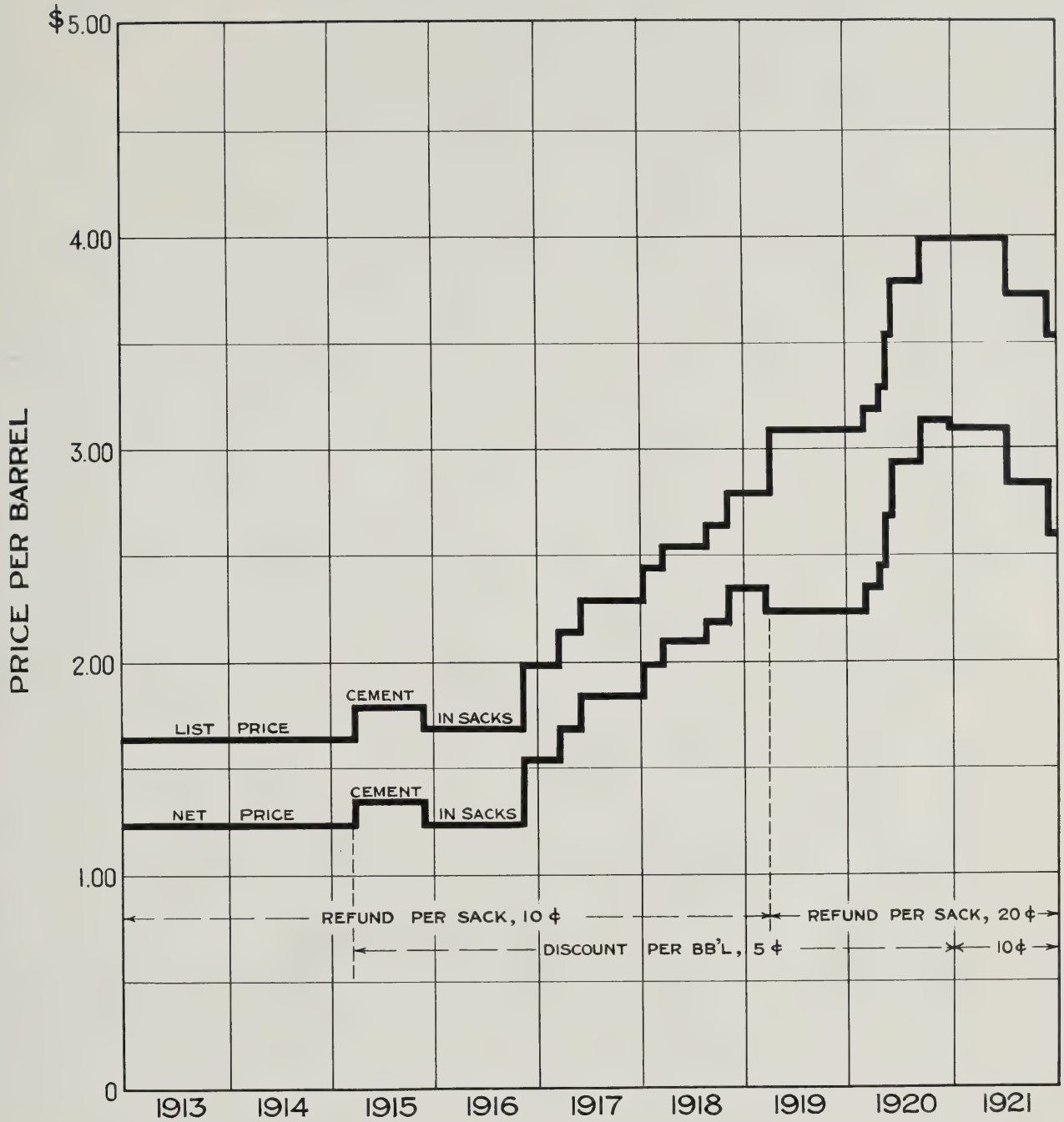
Also included herewith is a chart on page 266 which forms page M-37 of Chapter M of our Consulting Engineer's report. This chart indicates a variation in the price of cement during the period 1913 to 1921. It will be observed that from the year 1913 until the Fall of 1916, prices remained fairly constant, but during the period of 1917 substantial increases took place, and at the end of 1917 the rate had increased to about $2.00 per barrel as against $1.25 in 1916. According to cost index figures, based upon Engineering News-Record, a chart has been plotted, included herewith as page 244. This chart shows that normal conditions obtained during the period 1913 to 1915, but that a very great increase took place during the years 1916 and 1917. The index figure during the period 1913-1915 may be roughly taken at 90, while the index figure in 1917 is at an average of about 200. From the wholesale price index numbers obtained from the Labour Gazette shown by the chart on page 243, it will be observed that the cost of building materials increased from an index figure obtaining in 1915 of 100, to 175 as at the end of 1917. WJP. M-36

Wage rate figures from the Department of Labour have been obtained and curves plotted which are included herewith as page 246. The composite curve shown as that lettered "B" on the diagram indicates a very great increase during the period 1915, 1916 and 1917. The index figure for 1915 is approximately 105 and that obtaining at the end of 1917 about 135. WJP. M-7

1918 to 1919, of approximately 55 per cent. It is interesting to note that the increase during 1918 has been even higher than in previous years, thus indicating to some extent the conditions to be expected.

Also included herewith is a chart on page 266 which forms page 5-17 of Chapter 5 of the Committee Engineer's report. This chart indicates a relation in the price of lumber during the period 1913 to 1923. It will be observed that from the year 1913 until the fall of 1918, prices remained fairly constant, but during the period of 1917 substantial increases took place, and at the end of 1917 the rate had increased by about 50.4% per barrel to approximately $1.25 in 1918. According to such index figures, based upon comparative base-period, a change has been plotted, indicated herewith as page 144. This chart shows that normal conditions existed during the period 1913 to 1918, but that a very great increase took place during the period 1918 and 1921. The index figure during the period 1913-1918 may be roughly taken at 50, while the index figure in 1917 is at an average of about 130. From the wholesale price index numbers obtained from the Labour Gazette shown by the chart on page 143, it will be observed that the cost of building materials increased from an index figure relating in 1913 of 100, to 172 as at the end of 1917.

Page note figures from the Department of Labour have been obtained and survey plotted which are included herewith on page 146. The composite curve shown as that lettered "F" on the diagram indicates a very great increase during the period 1913, 1916 and 1917. The index figure for 1913 is approximately 100 and then rotating at the end of 1917 about 180.



HYDRO-ELECTRIC INQUIRY COMMISSION

W. D. GREGORY, CHAIRMAN

QUEENSTON-CHIPPAWA POWER DEVELOPMENT

CURVE OF PORTLAND CEMENT PRICES AT NIAGARA FALLS, ONTARIO BASED ON CANADA CEMENT Co. DATA

Toronto, July 27th, 1923. Made by G.E.R., Checked by C.A.H.

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS

The conditions disclosed by the analysis given above were well known in engineering and contracting circles, and should have been more fully recognized by the Commission, when submitting their figures to the Government. On the contrary all statements made to the Government in respect of costs were written in a most optimistic way and gave definite assurance that every conceivable condition had been taken into account and that the estimates submitted could be safely taken as an outside figure of the cost. There are 3 ways of looking at the
1. Engineering
2. Salesmanship
3.

It is not to be concluded from the foregoing remarks that the engineers of the Commission failed entirely to provide for increases in labour and material costs in Estimate No. 2, as, from examination of the details underlying this estimate, it appears that a certain provision was made in this respect. It is difficult after the lapse of several years to form an opinion as to just what should have been anticipated at the time Estimate No. 2 was prepared, but it may be stated generally that the bases, used by the engineers in preparing their estimate, were not on so liberal a scale as would be concluded from the statements made by the Commission to the Government at that time. This fact in combination with their all too liberal anticipation in respect of the working output capacity of the excavating equipment, which subject is dealt with in detail later in this report, resulted in an estimate which was much too low to cover the costs of the work during the period of construction contemplated and under the conditions as they then knew them.

The conditions disclosed by the analysis given above were well known to engineering and contracting circles, and should have been fully recognized by the Constabulary, when submitting their figures for the government. In the security all statements made to the Government in respect of costs were written in a more optimistic way and gave definite assurance that very considerable savings had been made into account and that the estimates submitted could be safely taken as an upside figure of the cost.

It is not to be concluded from the foregoing remarks that the engineers of the Constabulary failed entirely to provide for increases in labour and material costs in Statement No. 2, on from examination of the details underlying this estimate. It appears that a certain provision was made in this respect. It is difficult after the lapse of several years to form an opinion as to just what allowed have been anticipated at the time Statement No. 2 was prepared, but it may be stated generally that the basis,used by the engineers in preparing their estimate, were not so illogical a basis as would be constituted from the statements made by the Constabulary in the Government at that time. This fact is emphasized with their all the liberal anticipations in respect of the varying actual quantity of the accounting equipment, which engineer is least sure in assigning issue in this report, resulted in an estimate which was much too low to serve the basis of the work during the period of construction contemplated and under the conditions as they then came them.

To sum up, when the engineers of the Commission completed Estimate No. 2 in December, 1917, they were aware of and should have appreciated the following facts:

1. That the costs of material and labour were rising and that everything pointed to still higher prices and more unsettled conditions.

2. That the contractors replying to the Commission's request for tenders made no secret of the fact that they would not risk making a firm bid.

3. That the actual excavation done at the time Estimate No. 2 was made was of a comparatively simple nature and small extent, and could not be a reliable indication of the future costs, and that only one of the large shovels on which the Commission relied so greatly had commenced operations, and only to a very limited extent, having excavated only 9,236 cubic yards to December, 1917.

4. That the core borings available on March 4th, 1916, established conclusively that trouble would be encountered through wet excavation.

Yet with this knowledge, the engineers reduced the estimated unit cost for excavation below the unit costs used in Estimate No. 1, which unit costs were, in our opinion, already too low. When one remembers the unsettled conditions existing at the time, it is difficult to understand why anyone would reduce an estimate, but the reduction was made apparently through faith in the efficiency of the large electric shovels, although only one of them had actually commenced its task, for Mr. Acres in Estimate No. 2 says:

"It becomes evident therefore that by reason of the greatly increased efficiency of the plant to be used, as compared with ordinary construction plant, and the cheapness of electric power as compared with steam generated power, it will be possible to take earth and rock out of the canal at the present time as cheaply as it could have been taken out with the ordinary type of steam driven plant under pre-war conditions." p.11

To see you, then the minister at the Presidency answered:

Saint-Ouen, 6 to December 1917, they were aware of and should have

accepted the following facts:

1. That the cause of modernist was losing some ground and that everything pointed to still higher prices and more unstable conditions.

2. That the commandeers replying to the Constantinople request for another loan in order to keep the food and fuel supply and also making a free bid.

3. That the actual occupation date at the time Estimate No. 2 was made was if a significantly shorter period than would actions, and could not be a reliable indication of the future course, and that only one of the large-scale on and the Commandeers relied on already had occurred and operations, and only in a very limited sector, having extended only twelve miles to Bucharest, 1917.

4. That the core [illegible] on March 18, 1918, which already successfully had troops, would be considered another wet assessment.

In this data Investigation, the commanders assumed the situation that was the exception rather than the rule; were based on Estimate No. 1, which was just under way. In our opinion, already the lines. Then was considered the essential conditions existing at the time, it is difficult to understand the course pursued under or attempts, but the execution was more successfully through fault in the activities of the Junior Staff. Although they had at time the national economy in Paris, the two sides be balance for 3 years:

"It seems quite clear that by reason of the growth Germany allotting of the plant to be used, as compared with military construction alone, and the shortage of skilled labor as matched with other production priority, it will be impossible to take such and such or the present also as people to it would have been taken our with the military type of state driven plant under current conditions."

No Revisions in 1917 Estimates Until 1920

Estimate No. 2 is the last estimate as such ever prepared in detail by the engineers of the Commission. It did, however, form the basis of what we call Estimate No. 2-A and Estimate No. 2-B the figures of which were used by the Commission up to the end of 1919, and which we will now discuss.

We repeat hereunder for purposes of convenience a summary of the figures being officially used by the Commission as representing the cost of the work late in 1919:

Estimate No. 2 - December 26th, 1917	$24,316,815
Additions in respect of Estimate No. 2-A, January 3rd, 1918	786,100
Additions in respect of improved intake, late in 1919	1,922,720
Total of estimate late in 1919	$27,025,635
Deduct for gathering tubes not built, say	500,000
	$26,525,635

These figures representing a total estimate of $26,525,635 covered the works as now constructed for a six-unit installation, if allowance be made for such items as amendments for final quantities. We refer to this estimate for purposes of convenience as Estimate No. 2-B, and the following is a comparison of Estimate No. 2-B with the actual cost of the six-unit plant as now built:

The Conclusion in 1917 Commerce Still Lost

Actually, the U. S. did retain a very good commercial position in consequence of the Conclusion. It did, however, lose the basis of some of the most intimate ties, the ties that existed in the figures of major cases used by the Conclusion, in the year of 1912, and which are still not diminished.

The request hereunder for purposes of convenience a summary of the figures which actually were by the Conclusion as representing the year of the with lost in 1917:

Balance Dec. 1 - December 1916, 1917	$19,374,317
Additions in interest at rate of 6%	
Dec. 1-4, January 1917	[illegible]
Additions in respect of interest	
Lapses, Jan. in 1917	[illegible]
Total of ultimate loss in 1917	$27,[illegible]
Amount for publicity under act	
.....	[illegible]
	$20,000,000

These figures representing a total liability of $20,000,000 against the Conclusion are interpreted by a closely investigation of allowance in case the case lines on October 31,1917 which constitute. To view in this attitude the payment of assessment on Dublin the 3-4, and the Clinchor 24 a assessment at $[illegible] for annual cost of the six-mail plant as now built:

Comparison of Estimate No. 2-B with 6-Unit Plant as Built

Items	Estimate No. 2-B		Plant as built - Complete for six Units
Intake	$ 2,896,420	.....	$ 2,500,000
Welland River	533,384	.....	1,500,000
Canal	8,240,838	.....	36,500,000
Forebay	399,874	.....	1,250,000
Screen and Gate House ...	360,708	.....	1,750,000
Bridges	610,323	.....	2,650,000
Right-of-way	600,000	.....	1,000,000
Penstocks	409,236	.....	1,250,000
Power House	1,660,150	.....	3,500,000
Power House Machinery and Equipment	5,018,000	.....	6,500,000
Miscellaneous	175,000	.....	150,000
	$20,903,933		$58,550,000
Less: Estimated cost of gathering tubes not constructed ...	500,000	.....	
	$20,403,933	.....	$58,550,000
Engineering, Contingencies, Administration and so forth	4,745,278	.....	-
Interest during Construction	1,376,424	.....	4,750,000
	$26,525,635	.....	$63,300,000
Power House Railway			200,000
Plant Salvage			3,000,000
Stores			1,650,000
Expenses of Plant Salvage			110,000
Miscellaneous Sales and Work Orders			60,000
Suspense Account			5,000
		Total	$68,325,000
Credit Plant, Stores Account and so forth, say			4,000,000
Net total cost of Six-Unit Plant as constructed			$64,325,000
Net Total, Estimate No. 2-B			26,525,635
Difference between Estimate No. 2-B and Estimated Cost as Built			$37,799,365

From this comparative table, it will be observed that the difference between Estimate No. 2-B as being officially used by the Commission late in 1919, and the cost of the work as built is $37,799,365. It is this advance of approximately $38,000,000 that we will discuss in the following pages of this report, and endeavour to show the reasons for the enormous increase in actual cost over estimated cost.

Our Consulting Engineer, Mr. Walter J. Francis, has made a careful study of the various things against which these differences totalling approximately $38,000,000 may be charged and, based on the figures which he has submitted to us and other information in our hands, we submit hereunder a balance sheet indicating in a general way those items against which this excess of cost over estimated cost may be charged:

Total Cost to complete six-unit plant	$64,325,000
Total of Estimate No. 2-B, late in 1919	26,525,635
Difference between Estimate and Cost	$37,799,365
Say	$38,000,000

Increases in Cost due to:

1 - Design		$ -	
2 - Quantities		7,196,075	
3 - Abnormal Expenditures, as per W.J.F..			
(a) Wage increases and inefficiency	$13,000,000		
(b) Materials	3,700,000		
(c) Equipment	2,500,000		
(d) Plant	3,700,000		
(e) Overheads and contingencies on above, say	5,580,000		
	$28,480,000		

Note:
This amount of $28,480,000 must be reduced by the amount allowed in the estimates to cover anticipated increase in labour rates and material prices, say 2,000,000 $26,480,000

4 - Other additional cost not included above:			
(a) Fires (Mr.Acres est.)	$1,000,000		
(b) Strikes (St.& L. ")	613,000		
(c) Unwatering (excess cost)	1,250,000		
(d) Right-of-way (not included above)	400,000		
(e) Overheads and contingencies on above, say	815,000	$ 4,078,000	$37,754,075
Say			$38,000,000

From this table it will be noted that the amount as distributed against the various items aggregated an amount which is very similar to the figure of $37,799,355 given on the previous table wherein a comparison is made of Estimate No. 2-B with the cost of the six-unit plant as built. In the following pages of this report, we will indicate as closely as possible how the various amounts have been arrived at and in our discussion of each item show what part of the expenditure so made was justified and what part may be chargeable as a truly excess expenditure.

Section 40

DIFFERENCES BETWEEN DEVELOPMENT AS ESTIMATED AND AS CONSTRUCTED

The main differences between Estimate No. 2, and its subsidiaries, Estimates Nos. 2-A and 2-B, and the plant as being built and completed in 1923 for six units, are described below.

Changes in Design

The total advance in cost of approximately $38,000,000 to be accounted for, as between the estimate late in 1919 and the plant as being constructed both on the six-unit basis, is the result of a combination of circumstances. The original Estimate No. 2 was for a canal of a nominal capacity of 10,000 cubic feet. We have shown that Estimate No. 2-A provided a concrete lining and a greater canal depth which increased this capacity to 15,000 cubic feet, and again by a further revision we have arrived at what we have termed as Estimate No. 2-B which provided an improved type of intake. Thus we find that the estimate in official use late

in 1919 provided for a design the component parts of which compare with the plant as now built, so that any increase in cost over costs then estimated cannot, to any marked extent, be attributed to change in design.

Actual Quantities exceed Estimates

Any increases in quantities due to the canal lining added by Estimate No. 2-A and additional quantities due to the improved type of intake added by Estimate No. 2-B were all provided for and embodied in figures officially in use by the Commission late in 1919. The quantities in the work as completed for a six-unit installation were, however, considerably greater than those provided for in the estimates. These quantities, therefore, gave rise to increased costs and in order to show what such increases were, we will deal with each item separately in the following paragraphs.

Welland River

The design provided for earth dredging in the Welland River to the amount of 2,500,000 cubic yards at 20¢ per cubic yard. The construction records show that at March 31st, 1922, about 1,200,000 cubic yards were removed at a cost of about 75¢ per cubic yard. Subsequent contracts for additional dredging have been let at 53¢ per cubic yard. It, therefore, appears reasonable to place the cost of earth dredging in the Welland River for six units at about $1,500,000, but the quantities in the completed six-unit plant will be about the same as used in the estimate. Therefore , while the cost of this work was largely increased, the amount of material being the same, no extra cost is chargeable on this account.

Canal

Originally it was estimated that the earth dredging in the canal would amount to about 282,000 cubic yards at 20¢ per cubic yard. At March 31st, 1922, over 1,250,000 cubic yards had been removed at an average cost of about 76¢ per cubic yard. A comparatively small additional amount of earth dredging is required to complete the canal for six units. It therefore seems reasonable to allow for 1,000,000 cubic yards of earth dredging in addition to that used in the estimate.

The original estimate for earth excavation in the canal has been exceeded by over 1,300,000 cubic yards, and the rock excavation in the canal has been similarly increased by about 430,000 cubic yards as compared with the estimate.

Concrete

Concrete of all classes was estimated at 248,283 cubic yards at an average cost of $8.80 per cubic yard. The concrete in the construction amounted to 304,299 cubic yards as at March 31st, 1922, being an increase of about 56,016 cubic yards of special concrete. Probably 60,000 cubic yards is a fair allowance for the total additional concrete in the canal, all of the class provided for in the estimate at the highest unit prices.

Rip-rap

Rip-rap was originally estimated at 186,640 cubic yards. At March 31st, 1922, 986,028 cubic yards of rip-rap had been placed, making a total of about 800,000 cubic yards of rip-rap over and above the estimated quantity.

Steel

The reinforcing steel placed in the work was much in excess of the quantity used in the estimate.

Sand

Originally it was estimated that the earth dredging in the canal would amount to about 200,000 cubic yards at 10¢ per cubic yard. At March 31st, 1913, over 2,000,000 cubic yards had been removed at an average cost of about 7¢ per cubic yard. A comparatively small additional amount of earth dredging is required to complete the canal for six miles. It therefore seems reasonable to allow for 1,000,000 cubic yards of earth dredging in addition to that used in the estimate.

The original estimate for earth excavation in the canal has been exceeded by over 1,000,000 cubic yards, and the rock excavation in the canal has been similarly increased by about 60,000 cubic yards as compared with the estimate.

Concrete

Concrete of all classes was estimated at 400,000 cubic yards at a average cost of 6¢.22 per cubic yard. The concrete in the structures amounted to 704,000 cubic yards up to March 31st, 1913, being an increase of about 54,000 cubic yards of special concrete. Probably 50,000 cubic yards is a fair allowance for the total additional concrete in the canal, all of it also provided for in the estimate at the higher unit prices.

Steel

Slip-rail was originally estimated at 100,000 cubic yards. At March 31st, 1913, 204,000 cubic yards of slip-rail had been placed, making a total of about 300,000 cubic yards of slip-rail, and also the estimated quantity.

Steel

The reinforcing steel placed in the work was much in excess of the quantity used in the estimate.

Forebay

In the forebay the estimate provided for 349,500 cubic yards of rock excavation, while the amount of rock removed was about 125,000 cubic yards more than the estimated amounts.

Screen House

The screen house contains greater quantities of work than were contemplated in the estimate. The rock excavation was increased by over 20,000 cubic yards and the concrete work was increased by about 16,000 cubic yards.

Power House

The rock excavation in the power house is about 75,000 cubic yards more than that provided for in the estimate.

The concrete in the power house is of a more costly type than that used in the estimate, this being largely due to the development of the Moody spreading draft tube design subsequent to the time the estimate was prepared. The superstructure as built is larger than that figured in the estimate and changes have been made in the design so as to gain flexibility and efficiency. It is fair to allow $400,000 more than the estimate for the revised design of the concrete work of the power house.

Equipment

The general design and cost of the equipment as itemized in the estimate is similar to that installed, if due allowance be made for

Turbines

In the Sunday Ta estimate (Section dar 2[illegible]) [illegible] of road discussions, while the amount of work remains [illegible] [illegible] years from the estimated amounts.

Steam Plants

The steam plant analysis presents quantities of work that were overestimated in the estimate. The work associated was lessened by over [illegible] while parts and the concrete work was increased by about [illegible] [illegible] parts.

Power Plants

The real [illegible] power plant is about [illegible] [illegible] parts more than that provided for in the estimate.

The shortfall in the power house is of a more serious type than that in the turbines, this being due to the development of the study regarding their data design requirement in the time the estimate was prepared. The superstructure as built is larger than that figured in the estimate and changes have been made in the layout so as to give flexibility and efficiency. It is felt by other [illegible] [illegible] [illegible] for the revised design of the machinery and of the power house.

Equipment

The general design and cost of the equipment as included in the estimate is similar to that installed, if due allowance is made for

the advance in the capacity of the units purchased as compared with those of the estimate. A reasonable allowance for this would be a sum on the order of $300,000.

Bridges

The bridges and crossings cost much more than was contemplated in the estimate. This is due in part to the longer spans and heavier structures finally used as well as difficulties encountered before and during construction, which were not provided for in the estimate. The comparison of the estimate with the records of cost is complex. A reasonable allowance for the increased estimated costs due to the circumstances encountered amounts to a very large figure, probably on the order of $1,000,000.

Right-of-Way

We will deal at greater length with the subject of right-of-way in another part of this report. We will point out at this place only that the right-of-way as purchased was much greater than that provided for in the estimate and the actual expenditure of $1,424,000 is over $800,000 in excess of that contained in the estimate.

Having regard to the fact that the right-of-way provides sufficient land for more than one development, the whole of this amount is not chargeable entirely against the present plant or if the extra land is not utilized in this way additional acreage purchased may be sold and in this way represents a recoverable asset. Our Consulting Engineer

The reason is the capacity of the cable permitted us compared with those of the existing. I recommend allowance for this would be a loss to the amount of $20,000.

Letters

The letters and accounting book were here that we complained in the matter. This is due in part to the longer space and further structure itself was as well as difficulties encountered before and during construction, which were the problem for in the matter. The comparison of the estimate with the results of 1941 is complete. A reasonable allowance for the increased estimated costs due to the circumstances mentioned amounts to $[illegible], approximately, the order of $14,000.

Line-clearance

We will deal at greater length with the matter of right-of-way in another part of this report. We will point out in this place only that the right-of-way on [illegible] was greater than that provided for in the estimate and the actual expenditure of $[illegible] is over $[illegible] in excess of that mentioned in the estimate.

Having regard to the fact that the right-of-way provides additional line for more than one development, the [illegible] of this item is not chargeable entirely against the present plant or if the entire land is not utilized in this way additional expense [illegible] may be will not be this way [illegible] a [illegible]. The Controlling Engineer

states that a reasonable allowance for right-of-way for a six-unit plant is about $1,000,000 being $400,000 greater than the amount provided for in the estimate, and $400,000 less than the actual expenditure.

Miscellaneous

The service tunnel and the sundries check closely with the estimate.

The item of expenditure for power house railway, plant salvage, stores and so forth, were apparently not included in the estimate, unless in the unit prices or in the general allowance for overhead costs during construction.

In order to compare the total $26,525,635 of Estimate No. 2-B with the total of $64,325,000 for the six-unit plant as built, it is necessary to place them as nearly as possible upon the same basis as the conditions assumed in the estimate made in 1917 and subsequently carried forward to the end of 1919.

Summary

Now that the differences between the Development as estimated and as constructed have been analyzed, we submit hereunder a table prepared by our Consulting Engineer which shows a revision of the estimate in use late in 1919, corrected for quantities as actually built, but using the same unit prices as were used in the estimates. This table is as follows:

Revision of Estimate No. 2-B based on Quantities as Built

Based on the quantities contained in the plant as built, Estimate No. 2-B would have appeared as follows:

Total of Estimate No. 2-B with quantities given therein		$26,525,635
Additional Quantities:		
Canal, 1,000,000 cu.yds.dredging at .20	$ 200,000	
1,300,000 cu.yds.earth at .27.....	350,000	
430,000 cu.yds.rock at .98	421,000	
60,000 cu.yds.concrete at 12.00	720,000	
800,000 cu.yds.rip-rap at 1.50	1,200,000	
Forebay, 125,000 cu.yds.rock at .98	120,000	
Screen House, 20,000 cu.yds.rock at 1.00	20,000	
16,000 cu.yds.concrete at 12.00	190,000	
Power House, 75,000 cu.yds.rock at 1.50	110,000	
Changed concrete and superstructure, say, ...	400,000	
Equipment, 30,000 H.P. additional	300,000	
Bridges, about	1,000,000	
Right-of-Way, additional lands, say, ...	400,000	
	$5,431,000	
Engineering, contingencies, administration and so forth, and interest during construction, 32-1/2 per cent.	1,765,075	$ 7,196,075
Total for Estimate No. 2-B based on quantities as built		$33,721,710

From this table it would appear then that, aside altogether from the question as to whether unit prices used in the estimate were correct or not, on the basis of quantities alone and other general conditions, the cost was underestimated to the extent of $7,196,075.

It is not unusual in construction work of large extent to find that quantities are more or less than the amount estimated as it is impossible to foresee every condition in its true light before the work is actually undertaken. As a rule, however, excesses are compensated for by other items which are overestimated and, in the aggregate, actual cost is little affected.

In this work, however, we have a condition which shows that the main items of work were considerably underestimated with respect to quantity and, while there may be just reason for some of these excesses, the great majority appear to be the result of a none too liberal allowance for work of this character. When one considers that this excess on the basis of the estimate amounting to over $7,000,000 represents approximately 27 per cent. of the estimate, its importance may be understood. Nothing, so far as we can learn, was ever said to the Government regarding this additional cost which would have to be borne, so that even had it been possible to execute the work at the unit costs given in Estimate No. 2, the statement of cost given to the Government and that in use by the Commission late in 1919 would have been exceeded by over 27 per cent. As in other things, the Commission apparently considered it unnecessary to advise the Government of this overrun which so materially affected the cost.

not good business

Section 41

ABNORMAL CONDITIONS

General

The expenditures on the Development were largest in the years 1918, 1919, 1920 and 1921, increasing in amount as the years passed. During 1919, 1920 and 1921 material and labour costs were relatively high and the efficiency of labour was low. The general conditions obtaining were very unfavourable for construction, to such an extent indeed that ordinary construction was deferred and in many instances stopped to give way to war needs or to await the completion of the post-war re-establishment.

Mr. Acres says he is firm in his conviction that the excavation work of the canal could not have been completed at an earlier date under the circumstances encountered,- the faces of the rock excavation on the sides of the canal were lined with concrete as the result of a decision to increase the capacity of the canal subsequent to Estimate No. 2 and until the rock excavation in the canal had been finished it was not possible to make the concrete lining. Moreover, it would not have been prudent to expose the concrete lining through a winter season, so it was necessary to complete it in a working season during the Spring, Summer and Autumn of the same year. WJF. K-32

The power house and screen house were useless until the canal was ready to serve them, and it would have been imprudent to have them

Section 14

Economic conditions

General

The expenditures on the Development were largest in the years 1924, 1925, 1926 and 1927, increasing to nearly as the years passed. During 1928, 1929 and 1930 material and labour were even relatively high and the efficiency of labour was low. The general conditions prevailing were very unfavourable for construction, in such as returns further that ordinary construction was difficult and in many instances changed to site way to war needs or to avoid the complication of the pre-war requirements work.

Mr. Jones says he is firm in his conviction that the construction work of the canal could not have been completed at an earlier date under the circumstances prevailing. The time of the grub excavation on the sides of the canal was lined was greater as the result of a modification in increase the capacity of the canal originally in intends Mr. I put until the grub excavation in the canal has been finished it was not possible to make the concrete lining. However, it would not have been possible to square the concrete lining through a rocky column, so it was necessary to complete it in a working season during the spring, summer and autumn of the same year.

The grub lining and earth lining are a series until the canal was ready to serve them, and it could have been completed to date then

finished and standing idle. All of these factors resulted in congesting the heavy construction period into less than two years. Unfortunately these years were unique in their unforeseen abnormal conditions, insofar as the Queenston-Chippawa Power Development was concerned, although as we have shown elsewhere, when compared with average conditions throughout the country, the reduction in labour rates and inefficiency on this work appears to have lagged behind similar reductions elsewhere.

In order to determine the additional expenditure of money chargeable to abnormal conditions a close study has been made by our Consulting Engineer of the records in comparison with the conditions obtaining when Estimate No. 2 was prepared in 1917.

Wage Expenditures

The analysis of the wage expenditures is dealt with very fully in our Consulting Engineer's report entitled "Chapter M - Discussions", and, in brief, his analysis of this subject shows that of the total payrolls up to December 31st, 1921, amounting to $19,896,657 or say $20,000,000, about $7,000,000 is accounted for by increase in wage rates over 1917, and about $4,500,000 represents decreased output per man-hour as compared with 1917, leaving about $8,500,000 as normal wage expenditure for the plant as built up to the date above named. This normal wage expenditure would be reduced to about $6,100,000 for the quantities of Estimate No. 2. Allowance must be made in respect of wages paid subsequent to December 31st, 1921, for a six-unit plant, and, on this basis, the amount of $11,500,000 over and above normal wage expenditure should be increased to say about $13,000,000, as applying for wage increases and inefficiency for a six-unit plant.

Finance and standing this, it is hard to see further investment in maintaining the heavy manufacturing capital into long term plans for growth. Unfortunately these areas were major in their contribution towards employment, income in the Inter-Commerce Union Development and economics, although we do have some alternatives that suggest this strong manufacturing investment is crucial, the emphasis is shifting and particularly in this work expected to have longer lasting effects reductions elsewhere.

In order to determine the additional requirements of long term investment to support manufacturing a plan study has been made by the Inter-Union Bankers or the results is represented with the preliminary estimates for a new programme in 1957.

Inter Investments

The analysis of the major investments in Inter 1957 was only made in our Consulting Engineer's report entitled "Section 2 - Investment", and is brief. His analysis of this subject were lost in the total expenditure in December 21st, 1951, amounting to $12,000,000 in 1957-58-59-60, about $7,000,000 is accounted for by Lumbers in very short terms over 1957, and about $4,500,000 incorporate Harrowed output per man-hour as compared with 1957, leaving about $2,500,000 as normal wage requirements for the year, as shown by the late above table. This normal wage requirements which is reduced to about $2,100,000 for the quarterlies of between 50, 3, allowance may be made in support of wages yield subsequent in December 21st, 1951, for a growth plan, and, on this basis, the amount of $12,500,000 over and above normal wage requirements should be increased to say about $12,000,000, as applicable for wage increases and inflationary for a six-year plan.

Materials Expenditure

This subject has been carefully investigated by our Consulting Engineer and he has prepared certain figures from records relating to the cost of materials and equipment on the basis of 1917 conditions. Dealing with the subject generally, he says that index numbers and percentage cost records of many construction commodities including steel, cement, crushed stone, timber, ties, poles, brick, lime, rails, coal, piles, dynamite and so forth had been examined and the amounts paid year by year for supplies and materials have been noted. Applying these costs as a weighted mean to the cost of the ordinary materials amounting to $10,797,000 as purchased would have been about $7,500,000 at 1917 prices, while the estimated amount of $12,000,000 for the complete six-unit plant would be reduced to about $8,300,000. Thus we deduce the amount of abnormal materials expenditure as $3,700,000, as applying to a six-unit plant. WJF. M-33

Equipment Expenditure

The item for permanent equipment amounting to $8,791,000 is not subject to the same degree of yearly fluctuation as the ordinary materials, but judging by contract prices of similar manufactured equipment, it would appear that this item would have cost about $6,500,000 at 1917 prices and that the equipment for the complete six-unit plant would have been about $7,700,000, from which it may be fairly considered that there was an abnormal increase of about $2,500,000 for equipment for a six-unit plant. WJF. M-39

Plant Expenditure

From an examination of construction plant prices, it is apparent that the amount of $10,024,000 expended for plant would have been about $5,000,000 at 1917 prices. The salvage value would be correspondingly

Materials Inventories

This subject has been carefully investigated by our Construction Engineer and he has prepared various figures from records relating to the use of materials and equipment on the basis of 1941 conditions. Dealing with the subject generally, he says that labor shortage and priorities controls of many construction commodities including steel, cement, structural steel, timber, glass, paint, brick, lime, rails, coal, pipe, dynamite and so forth had been mentioned and the contents paid heed by them for supplies and materials have been noted. Applying these costs as a weighted mean to the cost of the ordinary materials consisting of $13,767,000 as previously would have been about $7,883,000 of 1941 prices, while the estimated amount of $12,040,000 for the complete six-mile plant would be reduced to about $8,300,000. Thus we reduce the amount of abnormal materials expenditure to $5,700,000, as applying to a six-mile plant.

Equipment Inventories

The item for permanent equipment amounting to $8,777,000 is not unlike to the same figure of pretty Construction at the existing ordinate, but judging by contract prices of similar construction equipment, it would appear that this item would have been about $7,344,000 at 1941 prices and that the equipment for the complete six-mile plant would have been about $7,140,000. From which it may be fairly considered that there was an abnormal increase of about $4,890,000 for equipment for a six-mile plant.

Plant Inventories

From an examination of comparative plant prices, it is apparent that the cost of $12,004,000 expended for plant would have been about $8,000,000 at 1941 prices. The saving value would be approximately

reduced, however, if the prices had remained the same as in 1917, so that the net amount for construction plant costs for the complete six-unit plant would have been about $3,500,000 or $4,000,000, and the abnormal plant cost for a six-unit plant would be on the order of $3,700,000.

Miscellaneous Overhead Costs

The item of miscellaneous overhead costs during construction, engineering, superintendence, administration, interest, and so forth, amounting to about $12,327,625 as at March 31st, 1922, is approximately 25 per cent. of the total of the other items.

Summary

Totalling the amounts given in the paragraphs immediately preceding and assuming approximate figures in respect of those items for which no exact figures are given, we obtain a sum which appears to be about $28,480,000, which figure may be taken as a fair representation of what may be said to represent expenditures of an abnormal character. These figures are set forth in tabular form on page 272.

The foregoing analysis has necessarily been based upon reducing actual costs to the basis which obtained in the year 1917. As pointed out previously, the engineers of the Commission stated that in Estimate No. 2 they had provided a reasonable amount in respect of wage rate increases and material costs. That they did allow a certain margin in respect of wages and material costs has been referred to in an earlier section of this report, but the amount so allowed was, in our opinion, too small, having regard to the labour and material market as it appeared at that time.

However, however, if the prices had remained the same as in 1938, so that the net annual depreciation plant would be for the complete plant would have been about $1,800,000 or $1,200,000, and the adjusted plant cost for a six-unit plant would be in the order of $1,700,000.

Miscellaneous Personnel Costs

The item of miscellaneous overhead costs during construction, engineering, superintendence, administration, interest, and so forth, amounting to about $12,527,427 as at March 31st, 1938, is approximately 25 per cent. of the total of the other items.

Summary

Building on the foregoing data in the paragraphs immediately preceding and assuming approximate figures in respect of those items for which no exact figures are given, we obtain a sum which appears to be about $22,245,000, which figure may be taken as a fair representation of what may be said to represent expenditures of an internal character. These figures are set forth in tabular form on page 37.

The foregoing analysis has necessarily been based upon preliminary actual costs in the tests which obtained in the year 1937. As pointed out previously, the engineers of the Commission stated that in their opinion, they had provided a reasonable margin in respect of some of the internal costs. That may did allow a certain margin in respect of some of material costs but have referred to be an earlier section of this report, but the amount is slight and, in our opinion, we shall, having regard to the labour and material costs as it appeared at that time,

The amount of $28,480,000 briefly referred to as representing expenditures of an abnormal character cannot be considered as such without further explanation. First of all, this figure has been arrived at by reducing the expenditures to conditions actually obtaining in 1917. Since the estimate then prepared did take into account certain increases in respect of wages and material, equipment and plant costs, the amount so provided must be deducted from this figure of $28,480,000. It is difficult to state with exactitude what this reduction should be, but an examination of Estimate No. 2 indicates that it would amount to about $2,000,000. Reducing the amount of $28,480,000 by the amount provided for in Estimate No. 2, we arrive at a figure of $26,480,000 which represents what may be termed abnormal expenditures of a character not provided for in any estimate prepared by the engineers of the Commission.

This new figure, $26,480,000, is also subject to further study, and we find that our analysis must be continued further if it is to be properly understood. We have already briefly referred to the fact that the output of the shovels was considerably less than that estimated by the engineers of the Commission, and in an ensuing section of this report we shall show as nearly as possible the effect that this condition had on the estimates and costs. At this juncture, however, it is necessary to point out that the failure of the shovels to give the expected output was indeed one of the governing features with respect to the matter now under discussion, namely, abnormal expenditures.

The amount of $[illegible],[illegible],000 primarily referred to as representing expenditures of an alternate character cannot be considered as such without further explanation. Even at all, this figure has been derived in by adding the expenditures to conditions normally obtaining in 1917. Some the estimate then prepared did take into account certain increases in respect of wages and material, equipment and plant costs, the amount so provided must be deducted from this figure of $[illegible],000. It is difficult to state with exactitude what this reduction should be, but on consideration of detailed do, I believe that it would amount to about $[illegible],000. Deducting the amount of $[illegible],000 by the amount provided for in Estimate No. 4, we arrive at a figure of $[illegible],000 which expenditure may be termed abnormal representing of a character not provided for in any estimate prepared by the authorities of the Dominion.

This new figure, $[illegible],000, is also subject to further study, and we find that our analysis must be continued further if it is to be properly understood. We have already briefly referred to the fact that the return of the aforesaid was constructed in the that estimated by the engineers of the Dominion, and in an amending section of this report we shall show in nearly as possible the extent that this modification had on the estimates and costs. In this instance, however, it is necessary to point out that the failure of the authorities to give the requested return was followed on of the preceding instance with regard to the construction and maintenance, namely, a renewed opportunity.

Abnormal Costs due to
Overestimated Shovel Capacities

The direct effect of overestimating the capacity of the shovels was to lower the estimated unit cost per yard of excavation. The indirect effects are numerous and it is to these matters that we will now particularly refer as having a bearing upon the amount of the abnormal expenditures.

The working schedule, like the unit prices, was based upon a certain output capacity per day; the number of days governing the length of time required to complete the work was in turn fixed by the daily capacities. With the working output of the shovels so materially reduced, the period of time to complete the work without an increased amount of equipment would be naturally extended. It was apparent and should have been appreciated from the beginning that the shovels could not maintain the output estimated upon. In order to correct in part this difficulty, more equipment was purchased, but this was not done until late in the work, when prices were very much higher, and when prompt delivery was difficult to obtain. Furthermore, the type of equipment, as originally contemplated by the engineers of the Commission, could not be obtained and other equipment had to be substituted therefor. This feature was particularly emphasized when the Commission found that in order to make their rush schedule effective, large steam shovels had to be accepted instead of electric shovels. The efficiency of the steam shovels according to the figures of the engineers of the Commission was considerably less than that of those electrically driven.

Referring back to the list of excavating equipment given on page 69 of this report and to the statement made in Estimate No. 2, that

equipment had all been purchased, we find that the engineers of the Commission apparently believed that with seven shovels consisting of two 332-ton electric shovels; two 118-ton electric shovels; one 30-ton steam shovel; one 30-ton electric shovel; and one 68-ton steam shovel, that the work could be completed within the time scheduled.

Subsequent to 1917, we find that six more shovels were purchased including two 332-ton shovels, one steam and one electric, one 118-ton electric, one 275-ton steam and two other steam shovels of smaller capacity. Three of these six shovels were purchased in the year 1920, one of the smaller ones even as late as November 1st, 1920.

This delay in getting sufficient equipment on the work was in a very large measure the result of the erroneous assumptions made by the engineers of the Commission in respect of capacities, and the delay was further increased by the difficulty of getting prompt delivery from manufacturers during the war period and subsequently. In turn this delay in getting a sufficiency of plant on the work was largely responsible for 60 per cent. of the rock excavation being crowded into the one year 1921, when wage rates and inefficiency were at their peak. The effect that the output capacity of the plant had upon the amount of equipment required and the speed of the work may be applied in varying degrees to almost every other part of the work. It vitally affected the transportation system, the number of men employed, the housing facilities and the commissariat, and, to some extent, the concreting work and so forth. It may be definitely stated that all other things being equal the operation of the excavating equipment was the governing factor in the whole undertaking.

equipment had all been purchased, so that the engineers of the Electric Company believed that with some models somewhere in the country the electric industry for 220-kv electric energy and three single-phase, 60-kv electric circuit, and 60-kv steam circuit, that the same would be complete with the line schedule.

Subsequent to 1927, so that six more circuits were purchased including two 220-kv circuits, one steam and two electric, one 110-kv circuit, the 220-kv steam and two water steam circuits of another capacity. Three of these six circuits were purchased in the year 1930, and the another were even as late as December 1st, 1930.

This delay in getting efficient equipment on the road was in a very large measure the result of the depression occasioned made by the engineers of the Commission in respect of capacities, and the delay was further increased by the difficulty of getting prompt delivery from manufacturers during the war period and subsequently. In view this delay in getting a sufficiency of plant on the road was largely responsible for the gap made, of the road accidents being avoided into the year 1931, when many more not inefficiency were at their peak. The effect that the output capacity of the plant had upon the amount of equipment required and the speed of the work may be applied to working figures to almost every other part of the work. It vitally affected the transportation system, the number of men employed, the housing facilities and the commissariat, and, to some extent, the accounting work and so forth. It may be distinctly stated that all other things being equal the question of the accounting equipment was the governing factor in the whole construction.

Justifiable Abnormal Expenditures

It will be observed that the amount of $26,480,000, which we have termed abnormal expenditure, is made up of three general amounts,- firstly, a certain proportion chargeable directly to the fact that the engineers of the Commission estimated the capacities of their equipment too high thereby decreasing estimated unit costs below those which could actually be realized; secondly, a proportion due directly to disorganization and delay in schedule as a result of overestimated shovel capacity, the consequent need of unanticipated plant with its belated ordering and arrival with the confusion and rush finally ensuing; and thirdly, a very considerable proportion made up of wage increases, inefficiency, increased cost of material over which items the Commission would have had no control.

We will in succeeding sections of this report show as nearly as possible the sub-division of this amount of $26,480,000 under the general headings just referred to.

Section 42

COMPARISON OF ACTUAL
COSTS WITH ESTIMATED COSTS

General

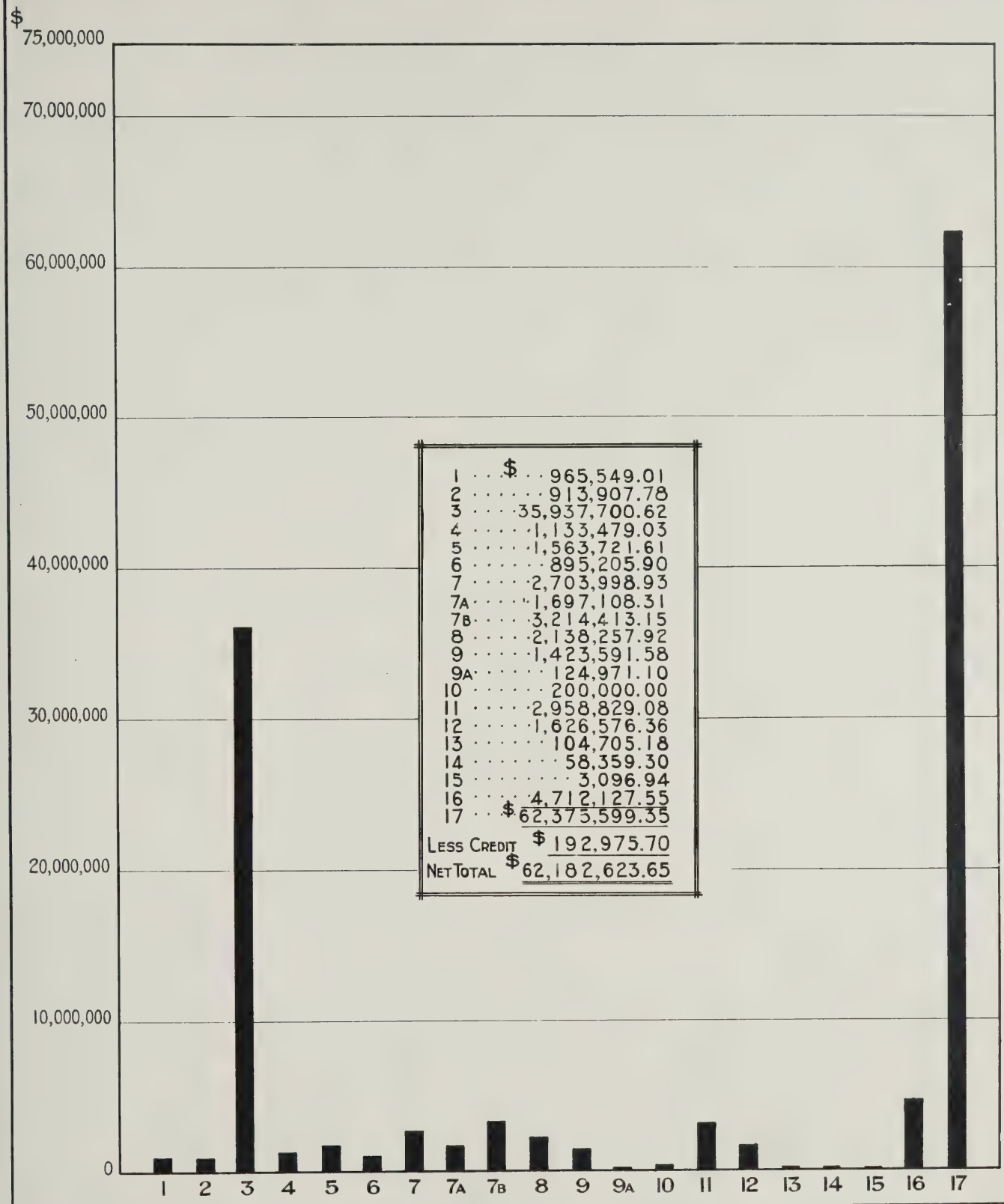
We have already stated in a general way that the actual cost of the six-unit plant as compared with the estimate in use by the Commission,

late in 1919, exceeded the estimate by nearly $38,000,000. We have accounted for over $7,000,000 of this excess by reason of increased quantities in the work. Of the balance remaining, viz: $30,600,000, we have shown that $26,480,000 represents abnormal expenditures, but that of this amount only part is truly chargeable as a justifiable abnormal expenditure. We will analyze this amount further, but before doing so it is well that some reference be made to those parts of the work in which the excess of cost over estimated cost is greatest.

Canal

As a matter of reference, we would refer you to page 290 of this report whereon is given a graphical representation of the total expenditures on the project to March 31st, 1922. Referring to Item No. 3, namely the Canal, we find the total expenditure to that date amounted to about $36,000,000 out of a total of $62,000,000. In other words the canal expenditure at that date, according to the analysis given represented nearly 60 per cent. of the total cost. For purposes of reference we include herewith as page 291 a further analysis made by our Consulting Engineer of this expenditure of $36,000,000 on the canal.

Analyzing the figures given thereon we find that of the $36,000,000 over $26,600,000 was in respect of earth and rock excavation. It is therefore apparent that the cost of earth and rock excavation on the canal governed, to a large extent, the cost on the whole work. Referring to Estimates Nos. 2 and 2-A, we find that the total cost of the canal section as estimated, with corrections made as in 2-A for the concrete lining, amounted



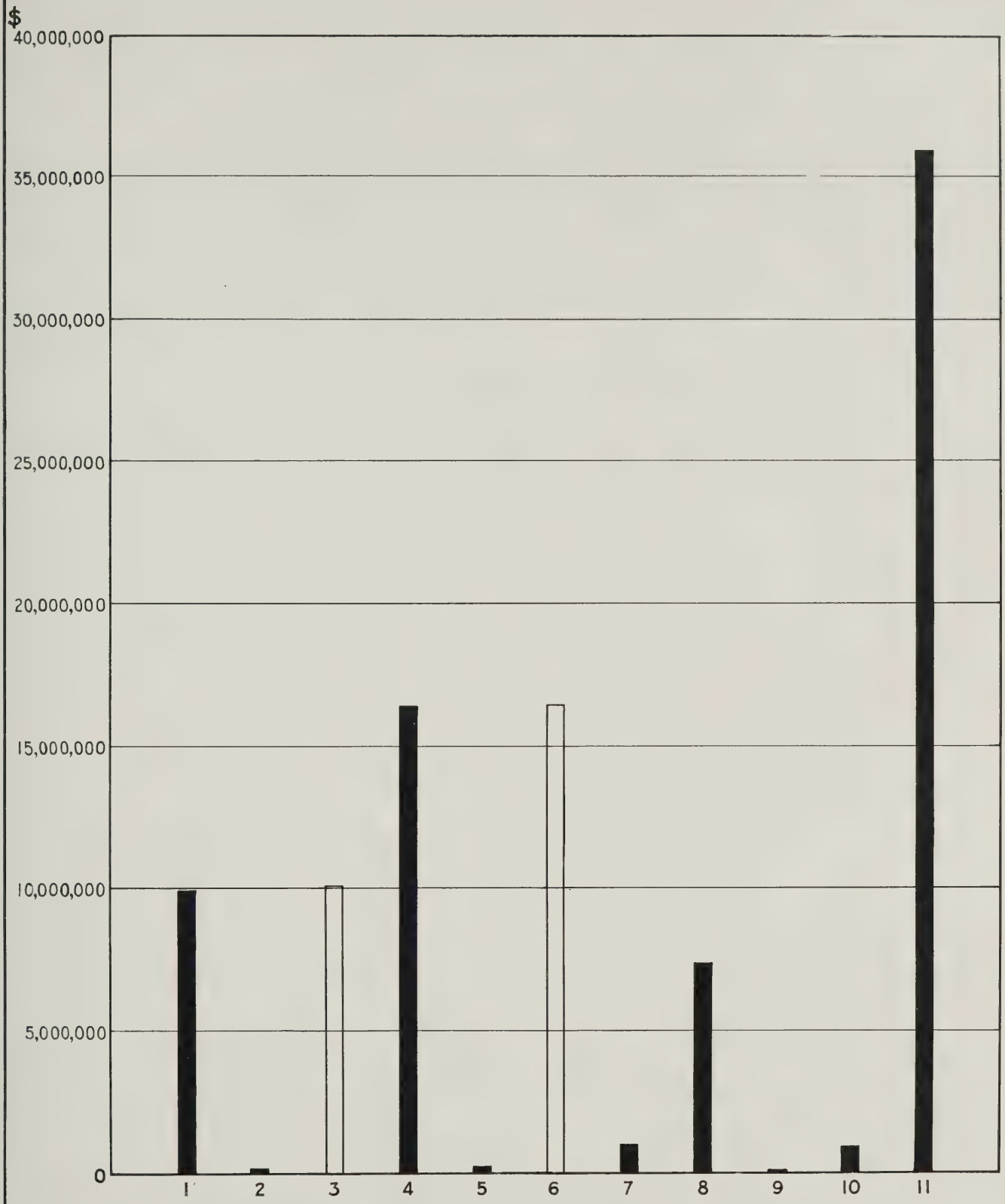
1	$ 965,549.01
2	913,907.78
3	35,937,700.62
4	1,133,479.03
5	1,563,721.61
6	895,205.90
7	2,703,998.93
7A	1,697,108.31
7B	3,214,413.15
8	2,138,257.92
9	1,423,591.58
9A	124,971.10
10	200,000.00
11	2,958,829.08
12	1,626,576.36
13	104,705.18
14	58,359.30
15	3,096.94
16	4,712,127.55
17	$ 62,375,599.35
Less Credit	$ 192,975.70
Net Total	$ 62,182,623.65

1 Intake
2 River
3 Canal
4 Forebay
5 Screen House
6 Penstocks
7 Power House
7A Hydraulic Machinery
7B Electrical Generation
8 Bridges
9 Right-of-Way
9A Miscellaneous
10 Queenston-Power House Ry.
11 Plant Salvage
12 Stores
13 Expenditures
14 Sales and Work Orders
15 Suspense Account
16 Bond Interest
17 Gross Total Cost

Hydro-Electric Inquiry Commission
W. D. Gregory, Chairman
Queenston-Chippawa Power Development
Cost by Construction Elements

TOTAL EXPENDITURE ON PROJECT

To March 31st 1922
Toronto, May 2nd., 1923, Made by [illegible] Checked by [illegible]
Walter J. Francis & Company
Consulting Engineers



1	Earth Excavation, Canal	$ 9,981,459.59
2	" " , Construction Ry.	174,876.36
3	Total Earth Excavation	$ 10,156,335.95
4	Rock Excavation, Canal	16,274,868.88
5	" " , Construction Ry.	189,480.06
6	Total Rock Excavation	$ 16,464,348.94
7	Dredging	1,003,780.92
8	Concrete	7,300,871.55
9	Structural Steel, Control Gate	61,289.55
10	Rip-Rap	951,073.71
11	Total (Canal)	$ 35,937,700.62

Hydro-Electric Inquiry Commission

W. D. Gregory, Chairman

Queenston-Chippawa Power Development

Cost by Construction Elements

EXPENDITURE ON CANAL

To March 31st 1922

Toronto, May 2nd., 1923. Made by S.P.H. Checked by C.J.

Walter J. Francis & Company

Consulting Engineers

to a total of $8,240,838. We have, therefore, this comparison that the canal section, which the Commission, late in 1919, were still figuring would cost $8,250,000, eventually cost nearly $36,000,000, or over four and one-third times as much as estimated.

One would naturally conclude, therefore, that the actual cost of the earth and rock excavation must have played a most important part in this additional expenditure. We have shown by our analysis of Estimate No. 2 that the estimated cost of earth excavation was 27¢ per cubic yard and of rock excavation 98¢ per cubic yard. Referring to page 130 of this report, we find that the average actual cost of all earth excavation work was 83¢ per cubic yard, and rock, $3.56 per cubic yard.

In submitting these unit costs to us, our Consulting Engineer has not included certain charges in respect of unwatering, costs due to strike, hospital and medical services, and main line railways and roads, but in order to compare estimated costs with actual costs, adjustment in respect of these items must be made. On this basis, we find that earth excavation cost about $1.05 per cubic yard and rock excavation about $4.24. Now by multiplying the unit costs as used in the estimate by our figure as given above of four and one-third, we arrive at units which are very similar to the actual costs. This, then, supports the conclusion that the cost of earth and rock excavation in the canal was the real governing factor in respect of the cost of the work on the Development. From this it must be concluded that the substantial part of the $20,600,000 yet to be explained must be involved in the earth and rock excavation which fact in turn brings us to the point of studying the actual operation of the excavating equipment.

to a total of $2,121,000. In turn, Schwabers, with computations that the canal restore, which the Superintendent, prior to 1919, were still figuring would cost $3,250,000, consequently must nearly $20,000,000 in order that one can claim these to be reasonable.

The world materially considers, however, that the annual cost of the works and their maintenance must have placed a most burdensome part in this additional expenditure. The data shown by the engineers of Schwabers Co. I find the estimated cost of works maintenance was $75 per mile; yet mile and of work maintenance $38 per mile year. Considering in page 120 of this report, we find that the average annual cost of all works maintenance was $24 per mile year, and work, $2.50 per mile year.

In calculating these data it must be so, the Superintendent engineers has not included capital charges in respect of depreciation. Note the in structure, bridges and vertical structures, and water flow gallonage and tracks, but in order to compute additional charges with without tracts, depreciation in respect of these items must be by tracks. The data tracks, or that that tracks maintenance cost about $1.50 per mile year and work maintenance tracks about $2.50 per mile year. Now by multiplying the work tracks or work in the waterway by our figures in place above of flow and non-flow, we arrive at totals which are very similar to the actual costs. This, then, suggests the conclusion that the cost of tracks and work maintenance in the canal has the real determining factor in respect of the cost of the work on the Development. Now this is that to ascertained that the substantial part of the $20,000,000 yet to be expended must be incurred in the work and work maintenance which has to run right up to the point of straight the actual operation of the navigating equipment.

Because of the greater labour factor

Before leaving the subject of comparisons, it is interesting to note that the costs of the other component parts of the work did not exceed so greatly the estimate as did the canal.

Intake

The estimated cost of the intake with deductions made for the gathering tubes which were not constructed amounted to $2,396,420, while the cost of the work as actually built amounts to $2,500,000. It is to be remembered that this part of the work was largely done by contract, in fact we have it from our Consulting Engineer's report that the total contract work as executed by Messrs. Tomlinson, Macaw & McDonald amounted to $436,727.60 at the estimated quantities.

WJF.
G-6.

Welland River

The total work in the Welland River section has greatly exceeded the estimate but not to the same extent as in the canal. The bulk of the work, namely dredging, accounting for over $500,000 of the original estimate of $533,000, was figured by the engineers of the Commission to cost 20¢ per cubic yard. Under the Commission's operation it cost over 75¢ per cubic yard, but they ceased operations in the Summer of 1921, the remainder being let by contract at unit prices varying from 33¢ to 40¢ per cubic yard.

Forebay

The cost of the forebay as at March 31st, 1922, exceeded the estimate by about three times. This compares more closely with the ratio

Before leaving the subject of conclusions, it is interesting to note that the costs of the minor component parts of the work did not exceed 4% (totally the estimate on all the work).

Dredge

The estimated cost of the dredge with deepening made for the qualifying dredge which was not commercial amounted to £2,324,424, while the cost of the work as actually built amounts to £1,[illegible]. It is to be remembered that this part of the work was largely done by contract. It may be noted it from the Engineering Inquiry's report that the total contract was in excess of Public Tenders, Ltd. [illegible] £[illegible] at the original quotation.

Tailing dyke

The total cost in the Tailing Dyke exceeds the quantity measured the estimate but not to the same extent as in the canal. The bulk of the work, namely dredging, amounting for over £800,000 of the original estimate of £[illegible], was figured by the engineers at the quantities in each 24 per cubic yard. Thus the Commission's operation it cost over 12d per cubic yard, but they carried operations in the theory of 1:1, the insulator being let to contract at half yrdlel working from 32p to 40p per cubic yard.

Foundry

The cost of the foundry on 31 March 1924, amounted the estimate by about [illegible] times. This concerns been discussed with the [illegible]

of increase to the canal and this is quite to be expected since, of the original estimate of approximately $400,000, $348,000 was chargeable to earth and rock excavation.

Bridges

The bridges estimated to cost $610,000 cost over $2,000,000.

Right-of-Way

Right-of-way, for which $600,000 was included in the estimate, by reason of increased purchases, cost over $1,400,000.

The remainder of the work consisting of gate and screen house, penstocks and power house, also greatly exceeded the estimates, but not to the same extent as the work in the canal.

Section 43

EFFICIENCY OF EXCAVATING EQUIPMENT

General

We have referred in the previous section of this report to what may be termed the indirect effects that the reduction of output had upon the cost of the work and have briefly stated that the direct results of over-estimating the capacity was to decrease the unit costs used in the estimate which in turn was one of the big reasons which caused the estimates to be so largely overrun. The following paragraphs in this section will be devoted to this direct result and we will endeavour to indicate what an important bearing this had on the correctness of estimates in use by the engineers of the Commission up to the end of 1919.

Output of Shovels

As before quoted, the report forming part of Estimate No. 2 states:

"The main factor affecting unit cost is the volume of the output of excavated material."

Again:

"In working out this schedule, the daily output of the excavating plant has been conservatively estimated according to the manufacturers' specifications....."

The estimated capacity of each type of shovel in earth and in rock was stated to be as follows:

Type of Shovel	Estimated Capacity in Ten Hours Earth Cubic Yards	Rock Cubic Yards	
225-B	5,000	3,000	WJF.
103-C	3,500	2,000	M-42

Our Consulting Engineer on page M-43 of his report entitled "Discussions" states as follows:

"The average maximum performance of the shovels over short periods of time was as shown below, although certain shovels exceeded the above estimated capacity on some occasions:

Shovel	Average Maximum Performance of each shovel in Ten Hours Earth Cubic Yards	Rock Cubic Yards
Nos. 1 & 2, 225-B	4,620	1,896
Nos. 3 & 4, 103-C	2,759	1,824

"

Subject of Interest

In matters general, the report formed part of Enclosure No. 2 stated:

"The main factor affecting this rise is the volume of low-wages of economically industrial."

Again:

"In working out this estimate, the daily output of the assembling plant has been conservatively estimated according to the manufacturers' specifications."

The estimated capacity of each type of manual is which can be made was stated to be as follows:

Type of Tunnel	Estimated Capacity in Per Cent of Each Month: Each Single Tunnel	Each Double Tunnel
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

The financial statement on page [illegible] of his report reflect "Miscellaneous" states as follows:

"The average monthly performance of his overall work shows profits of [illegible] as shown below, although certain months showed the [illegible] expenditure on some investment.

Items	Average Monthly Performance of each Service in the Month: Single Tunnel	Double Tunnel
Tun. I & E, [illegible]	[illegible]	[illegible]
Tun. 2 & 4, [illegible]	[illegible]	[illegible]

The above figures show that even the average maximum performance over short periods never reached the capacities estimated upon. Under ordinary working conditions estimated capacity should represent an average performance over a protracted period. As an illustration, if a shovel of the 225-B type could be safely depended on to give a working output of 5,000 cubic yards in ten hours, then under the most favourable conditions its capacity per shift would have to be greatly in excess of this figure. Under adverse conditions the output would be greatly reduced, but the average or mean capacity, taking all things into account such as hard digging, adverse weather conditions, breakdowns, poor train service and so forth, would be 5,000 cubic yards to meet the estimates.

Capacities greatly Overestimated

As an indication of actual conditions obtaining on the work, we submit hereunder a table which has been compiled from figures given in Mr. Acres' replies to contractors' evidence, Appendix 16, page 3:

Shovel Number	Summary of Electric Shovel Performance giving Cubic Yards per Ten-hour Shift		
	Estimated	Actual Output	Per cent. Efficiency
Earth			
1 (225-B)	5,000	2,051	41.02
2 (225-B)	5,000	1,612	32.24
8 (225-B)	5,000	-	-
3 (103-C)	3,500	873	24.94
4 (103-C)	3,500	522	14.91
9 (103-C)	3,500	-	-
Average for 225-B	5,000	1,732	34.64
Average for 103-C	3,500	773	22.08
Rock			
1 (225-B)	3,000	1,051	35.03
2 (225-B)	3,000	939	31.30
8 (225-B)	3,000	-	-
3 (103-C)	2,000	-	-
4 (103-C)	2,000	-	-
9 (103-C)	2,000	-	-
Average for 225-B	3,000	1,066	35.53
Average for 103-C	2,000	490	24.50

[illegible]

[illegible]

[illegible]

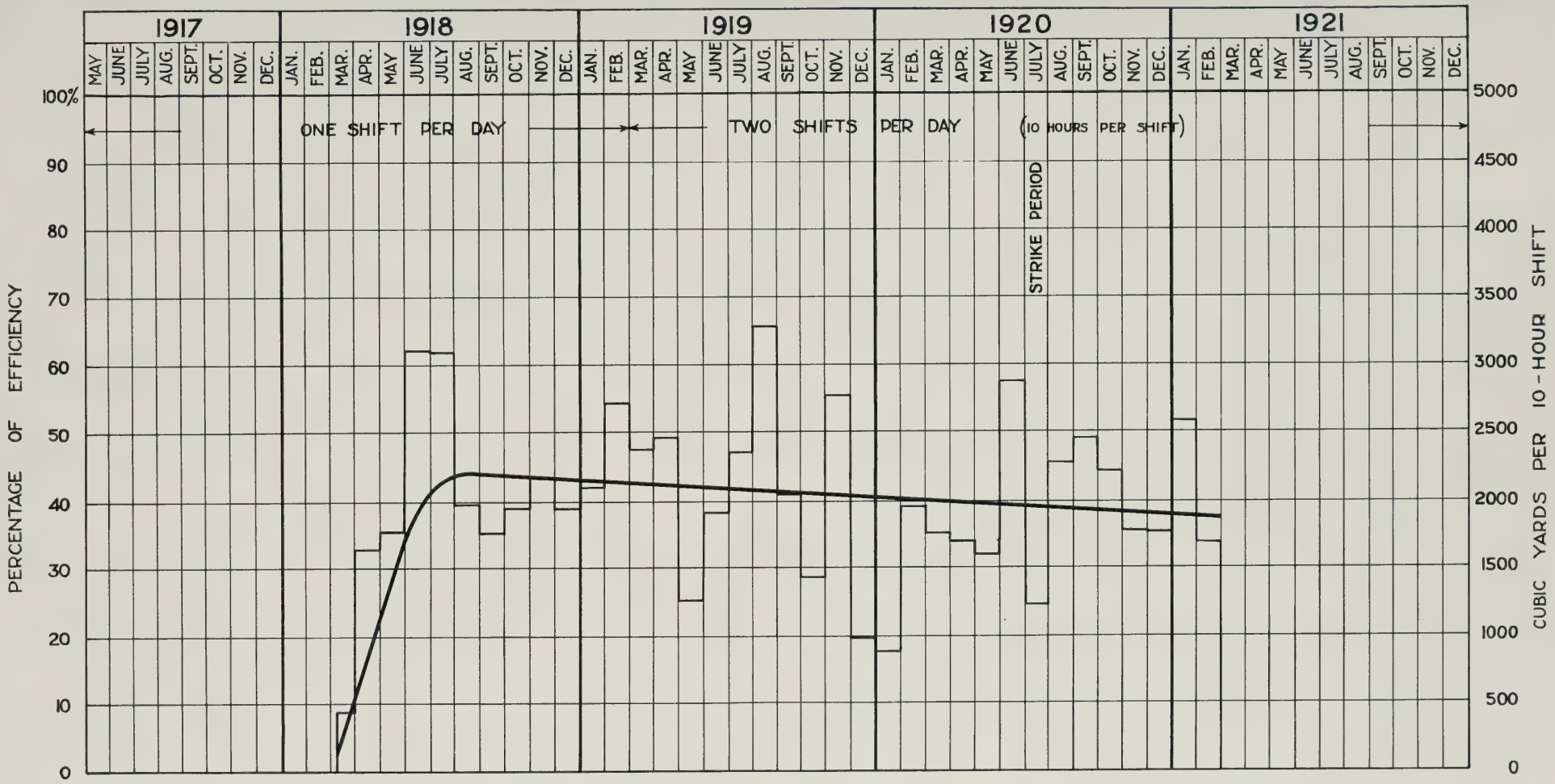
From this table it will be observed that the main excavating units employed by the Commission delivered only from one-quarter to one-third the amount of material which was anticipated in the estimates. This was undoubtedly a very important cause of the substantial increase in the cost over the estimate.

Now it is to be noted that the analysis given in the above table takes into account only the two largest types of shovels used on the work and that the shovels referred to were electrically driven and that the engineers of the Commission maintain that the efficiency of these shovels was much in excess of the steam driven plant otherwise employed. The figures above given can, therefore, be taken as representing a much better condition than actually obtained in the work if all equipment is taken into consideration. The shovels above mentioned, however, excavated the large percentage of material and it is for this reason that they have been used in these comparisons. In order to graphically represent what actually occurred with respect to the large electric shovels, 1, 2 and 8, we have had plotted in diagramatic form the progressive efficiencies in earth and rock excavation and these diagrams are included herewith as pages 298 and 299.

Looking for the reason bringing about this condition, one is naturally faced with the following questions:

1. Did the engineers of the Commission properly estimate the working capacity of the shovels?

2. To what extent was the inefficiency of labour responsible for the failure of the equipment?



THE EFFICIENCY PERCENTAGES ARE BASED ON 5,000 CUBIC YARDS PER SHOVEL PER 10-HOUR SHIFT IN EARTH AS BEING 100 PER CENTUM. (AS ASSUMED IN H.E.P.C. ESTIMATE No. 2.)

THE MONTHLY AVERAGE PERFORMANCE PER SHOVEL PER 10-HOUR SHIFT IS SHOWN THUS:

THE PROGRESSIVE AVERAGE PERFORMANCE PER SHOVEL IS SHOWN THUS:

HYDRO-ELECTRIC INQUIRY COMMISSION

W. D. GREGORY, CHAIRMAN

QUEENSTON-CHIPPAWA POWER DEVELOPMENT

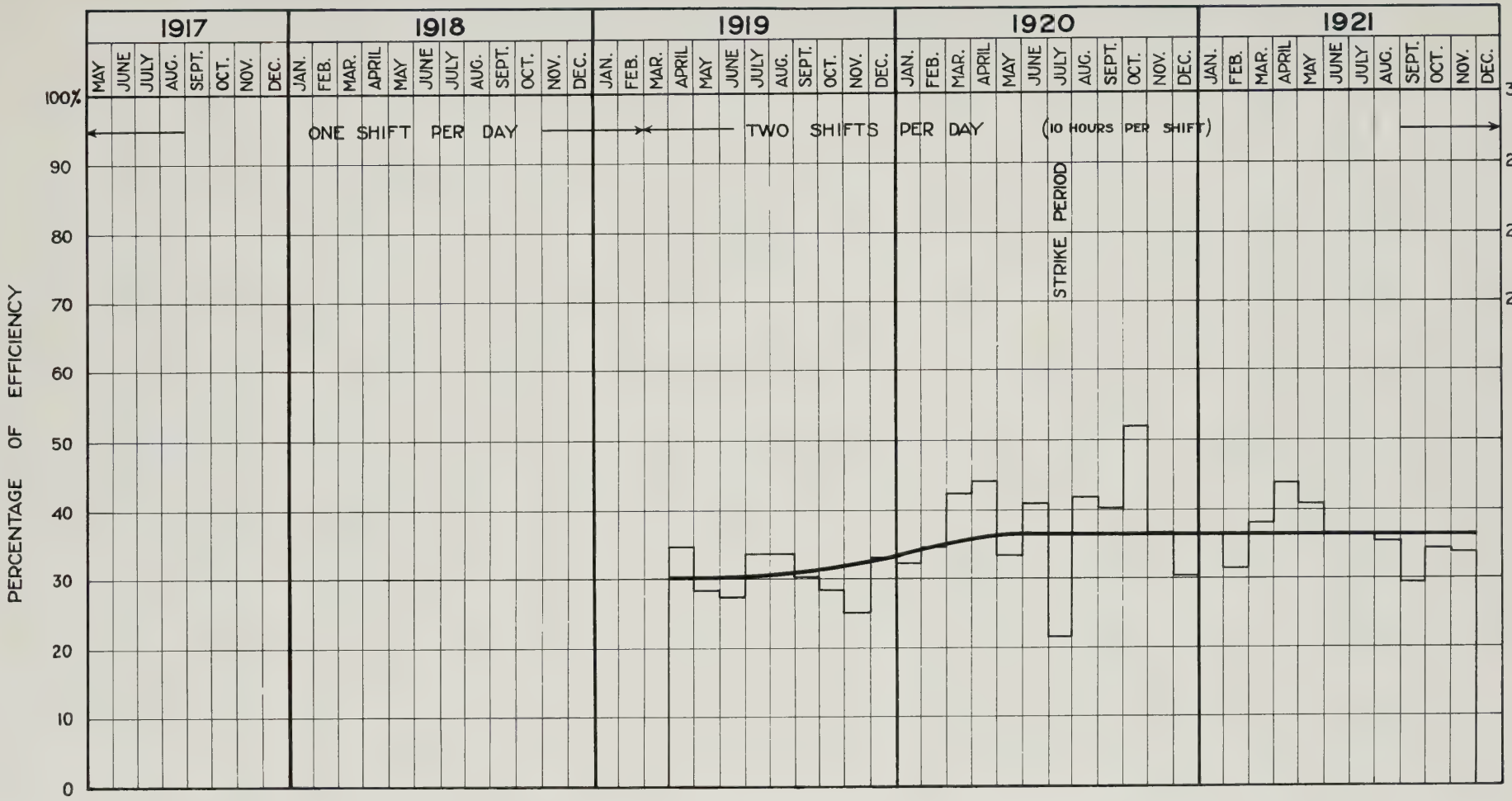
ELECTRIC SHOVELS 1, 2 AND 8, TYPE 225-B PERFORMANCE CURVES IN EARTH EXCAVATION

Toronto, Oct. 31st, 1923. Made by WDA, Checked by J.

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS

298



THE EFFICIENCY PERCENTAGES ARE BASED ON 3,000 CUBIC YARDS PER SHOVEL PER 10-HOUR SHIFT IN ROCK AS BEING 100 PER CENTUM. (AS ASSUMED IN H. E. P. C. ESTIMATE No. 2.)

THE MONTHLY AVERAGE PERFORMANCE PER SHOVEL PER 10-HOUR SHIFT IS SHOWN THUS:

THE PROGRESSIVE AVERAGE PERFORMANCE PER SHOVEL IS SHOWN THUS:

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

QUEENSTON-CHIPPAWA POWER DEVELOPMENT

ELECTRIC SHOVELS 1, 2 AND 8, TYPE 225-B PERFORMANCE CURVES IN ROCK EXCAVATION

Toronto, Oct. 31st, 1923. Made by [illegible], Checked by [illegible].

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Dealing with the first question, it is well to again refer to the statements contained in the report attached to Estimate No. 2:

> "The main factor affecting unit cost is the volume of the output of excavated material."

Again:

> "In working out this schedule the daily output of the excavating plant has been conservatively estimated according to the manufacturers' specifications."

The wisdom of the first statement will be apparent to everyone familiar with construction work, and the second statement indicates that the engineers of the Commission were largely guided by statements of the manufacturers. To what extent they were guided in this respect we will deal with presently, but at this point it is important to note that experienced contractors know that the statements of manufacturers are usually based upon short period operations and ideal working conditions, and that under ordinary working conditions, the output of shovels, concrete mixers and the like is usually very much less than the output claimed for them by their makers. In the report entitled "Comments on Evidence .... by Contractors on May 18th, 22nd and 23rd, 1923", Appendix 5, page 10, it is stated as follows:

> "The Canadian Equipment Company, from whom the shovels were purchased, also indicated in their letter of December 9th, 1919, that we were perfectly safe in estimating the capacity of the large 225-B shovels to be 5,000 cubic yards in ten hours."

In examining the letter in question, which is also quoted in Appendix 5, page 10, we find the company stated:

> "We believe that an average of 5,000 cubic yards per day of ten hours can easily be maintained."

Reading further, it is found that this statement is apparently based upon the performance of a shovel operating in the Pittsburgh-Kansas Coal Fields, where it is stated the company have records of an average of over 6,000 yards per nine-hour day. No doubt the information given by this company was correct, but the conditions under which these capacities were obtained were, as far as can be learned, greatly different from those obtaining on construction work. In operating a shovel in connection with a coal mine, a quarry or a clay pit, all conditions are known, the operation is usually continuous over short periods, and it is possible to arrange and systematize the work in a manner quite impossible in ordinary construction work. It usually happens that, under such conditions, a shovel will excavate much more material than is possible under the varying conditions encountered on construction work, and when assumptions are based on other than actual operating conditions they are almost sure to be misleading. Similar information to that quoted above is submitted in Appendix 5 of the above-noted report from the Bucyrus Bulletin. The capacities given in this bulletin are for shovels operating under conditions almost similar to those referred to by the Canadian Equipment Company, and the capacities obtained are generally comparable.

Engineers Disregard their own Conclusions

The engineers of the Commission did actually observe a model, No. 300 Marion, revolving shovel, operating in an earth cut on Section 13 of the Calumet-Sag Canal. In reporting upon this matter they state:

"At the time of our visit, the shovel was handling about 5,000 cubic yards in ten hours ....." p.12

Leading further, it is found that this statement is inconsistent based upon the performance of a larger competitor in the Pittsburgh-Lorain Coal field, where it is stated the company has produced [illegible] over 2,000 parts per time-year day. To demit the inconsistency given by this company was accurate, but the conditions under which these conditions were obtained were, in fact in one to lacking, generally different from those existing or existing on manufacturing work. In operating a device in conversation with a real view, a quarry or a city pit, all conditions are active, the operation is usually continuous over short periods, and it is possible to arrange and systematize the work in a manner very dependable to authority manufacturing work. It really happens that, under such conditions, a device will operate much more satisfactorily than it will under the varying conditions encountered in operating work, and that conditions are based on other than actual operating conditions they are always sure to be misleading. Similar information to that quoted above is published in Appendix C of the Navy-Metal report from the Bergen Mining. The superiority given in this report was for electric operating motor conditions closely similar to those patented in by the Carolina Equipment Company, and the conclusion obtained are generally comparable.

Engineer Discovered Flaws in Calculations

The engineers of the Consolidation did actually develop a model, to 300 horsepower, revolving drums, operating in an earth pit in Section 21 of the Calumet-Cog Coal. In reporting upon this motor they stated:

"At the time of our visit, the newest one handling about 2,000 cubic yards in ten hours ....."

Again:

"A conservative estimate with good train service would be 4,000 cubic yards per day of ten hours." p.23

While the engineers of the Commission observed that at the time of their visit to the Calumet-Sag work one of these large shovels was actually delivering 5,000 cubic yards of material in ten hours, no mention is made of an observation of the average capacity over reasonably long working periods. The output observed in the single occasion must have been considered above the average capacity for they suggest a reduced capacity as a conservative estimate contingent upon train service.

Notwithstanding the recommendation above made, we find the engineers of the Commission assuming that they can increase the working capacity from 4,000 yards to 5,000 yards per day for the purpose of estimating this job, and this in spite of physical conditions in respect of the Chippawa work which made it, in our opinion, very much more expensive than work that had been observed by them up to that time. The only reduction remotely provided for as regards average output would have resulted from the possibility of operating a few more days per year than they estimated upon.

Bad Working Conditions Discounted

The engineers of the Commission were well aware of the conditions likely to be encountered in the construction of this work, as the following statement appears on pages G-14 and G-15 of our Consulting Engineer's report entitled "Contract Work and Other Construction Procedure":

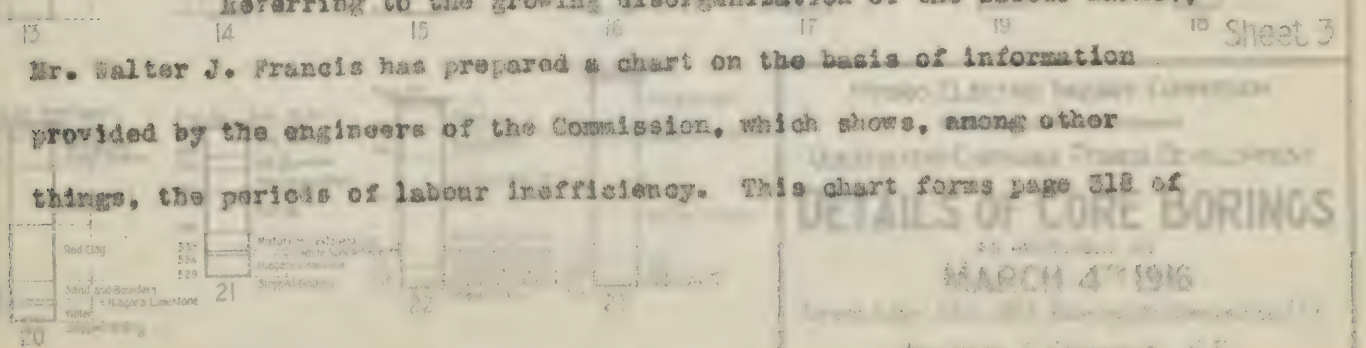
"At the time when it became necessary to actually commence construction work, therefore, the engineers of the Hydro-Electric Power Commission say that there were four outstanding conditions influencing the Commission as regards the general policy of construction procedure. These points were:

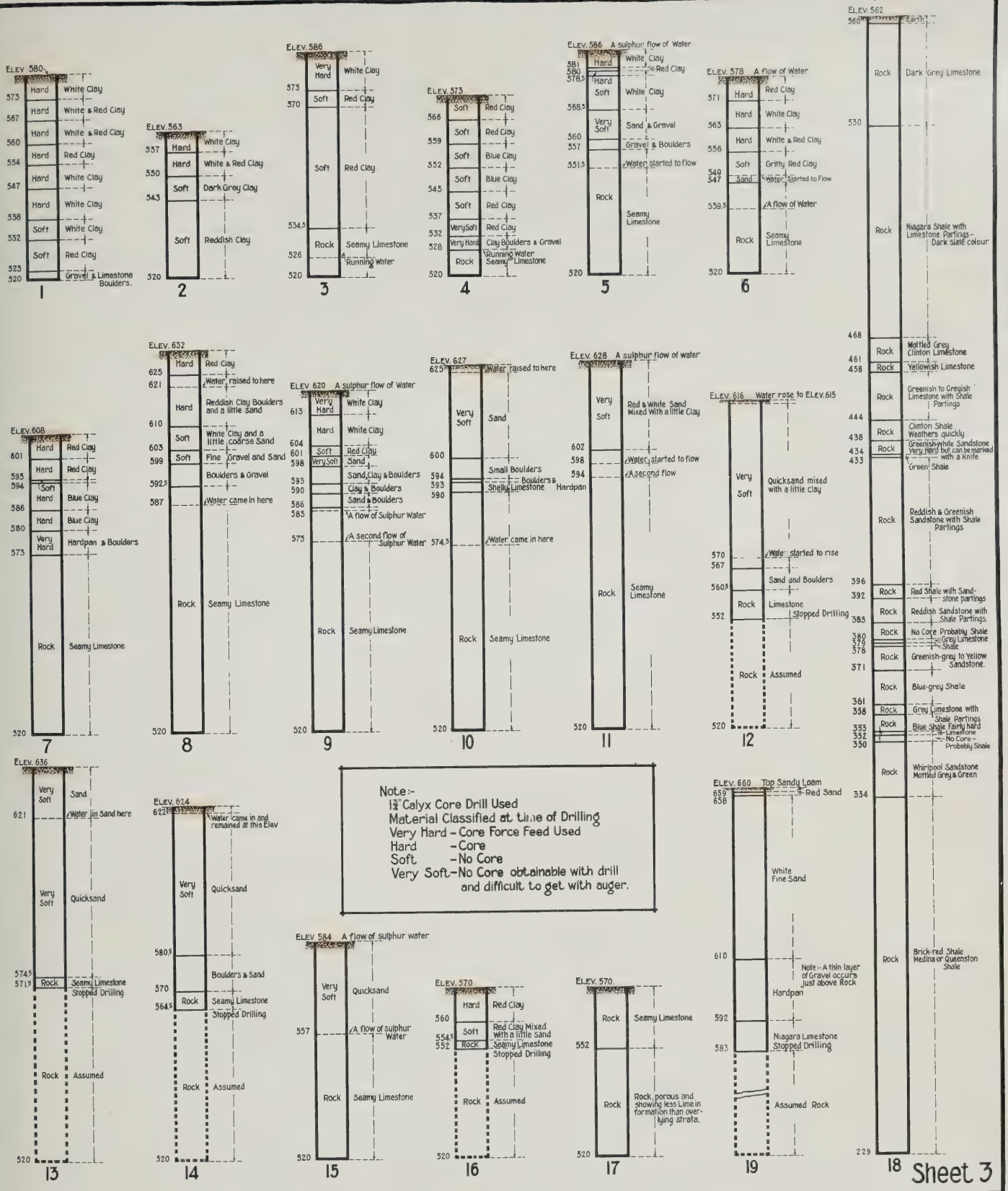
(a) The saturated condition of the earth overburden as evidenced by core drill surveys, and the consequent necessity of utilizing a special type of plant for removing the earth overburden;

(b) The growing disorganization of the labor market and raw material market, and so forth.

Referring to the saturated condition of the earth overburden, we include herewith as page 304 a diagram prepared by our Consulting Engineer indicating the conditions as shown by the core drills referred to as available at March 4th, 1916. From observing this chart, it must be concluded that the decision, arrived at by the Commission's engineers in reference to the saturated condition of the earth excavation, was sound, for the chart indicates that the character of work to be encountered was far from ideal. They state that they expected with ordinary drainage methods to easily handle the water encountered, but, in our opinion, the information given on the chart should have caused them to be most conservative in estimating the output capacity of the equipment. The engineers of the Commission were undoubtedly right when they decided to use large equipment which could operate from a firm foundation, namely, the rock surface, but they did not exercise mature judgment in anticipating that, in material of this kind and under the general working conditions, anything like the capacity estimated by them could be obtained.

Referring to the growing disorganization of the labour market, Mr. Walter J. Francis has prepared a chart on the basis of information provided by the engineers of the Commission, which shows, among other things, the periods of labour inefficiency. This chart forms page 318 of





For Location of Borings see Sheet 1

Hydro-Electric Inquiry Commission

W. D. Gregory - Chairman

Queenston-Chippawa Power Development

Details of Core Borings

as available at

March 4th 1916

Toronto, Nov. 24th., 1922, Made by [illegible], Checked by [illegible]

Walter J. Francis, C.E.,

Consulting Engineer

79

this report and reference to it shows that labour inefficiency did not apparently commence until the beginning of the year 1919. In Mr. Acres' "Comments on Evidence given by Contractors", Appendix 10, Table No. 2, is shown a record of comparisons of shovel efficiency. In this record it is shown that the efficiency of shovel output is greater in 1919 when labour inefficiency existed than in the year 1918 when, according to the first chart mentioned, there was no labour inefficiency.

Shovel Output regulates Cost

Mr. Acres apparently considers the failure of the plant to live up to expectations as the most important cause of the increased cost. In Appendix 16 of his report entitled "Comments on Evidence given before the Commission by Contractors on May 18th, 22nd and 23rd, 1921", he gives an analysis showing what the actual cost of excavating would have been if the shovels had realized their estimated capacities. In summing up the matter on page 9 of the above-noted Appendix, he states:

> "It therefore appears from the above that the unit costs with originally estimated capacities are actually less than the original 1917 estimates .... and show that had anticipated shovel capacities been realized and maintained,..... the actual cost of excavation would have been less than that estimated in 1917, even though handicapped by the inflated prices of labor and material."

What Mr. Acres says may be quite true. It is quite possible that the cost of excavation would have been less than the estimate had the shovels done what the engineers expected them to do, but the shovels did a great deal less than they were expected to do and, in our opinion, one

Mr. Hayes and relations to it shows that labour inefficiency has been especially noticeable with regard to the past year. In the Ontario Commission on Unemployment, appendix 10, page 20, it shows a reduced at employment of normal individuals. In this report it is shown that the efficiency of normal employ is greater when labour inefficiency matters over in the past year 1932-33, according to the three years previous, there was no labour inefficiency.

Normal Income Maintained Just

Mr. Lewis apparently considers the failure of the plant to live up to expectations as the most important cause of the unemployment here. It appears it is of his argument particularly convenient to criticize Jones before the Commission by Commissioner, Mr. Jones and Mr. Hill-he gives the analysis showing what the actual work of construction would have been if the Ontario had realized their estimated expenditure. In reading up the report on page 9 of the aforementioned appendix, he states:

> "It therefore appears from the above that the work which was originally estimated expenditure are actually less than the original 1917 estimates .... and show that had anticipated normal expenditure been realized and maintained.... the actual cost of construction would have been less than estimated in 1917, even though hamstrung by the inflated values of labor and materials."

Thus Mr. Lewis may be quite wrong. It is quite possible that the cost of construction would have been less than the estimate had the Commission been what the engineers expected them to be, but the Commission did a great deal less than they were expected to do and, in our opinion, one

of the fundamental reasons for the costs so greatly exceeding the estimate, is the faulty judgment of the engineers, for they estimated that the shovels would excavate much more than they possibly could have under the circumstances, and even when in 1918 and 1919 they knew what could actually be expected they failed to correct their estimates.

Engineers Believe Shovels operated Efficiently

In connection with our statement in reference to this matter, the argument may be advanced that the inefficiency of labour had a definite bearing upon the output of the equipment. In the first instance, it is to be remembered that, on a construction job of this character, the first concern is to keep the excavating units operating as continuously as possible, and the whole object is to see that the shovels are served with a sufficient number of men with trains and with other auxiliary services that will keep them constantly digging. It would appear that, aside altogether from the actual cost of operations, Mr. Acres has no criticisms whatsoever to make of the efficiency of the mechanical crews which operated the shovels. One of the witnesses appearing before us who was employed on one of the large electric shovels during the period 1920-1921 states as follows:

> "So far as the efficiency of the skilled workmen on the canal goes, I think there was a high standard of efficiency, particularly on the unit on which I was employed. We took out 130,000 yards of earth a month and loaded it in cars sixty feet above the shovel ... What I have said about the efficiency was general amongst the mechanics on the job." Ev. 2803

We believe that the statement made by this witness with reference to the efficiency of mechanics is quite correct, as it was generally found

throughout the war period that the efficiency of men employed in the skilled trades was fairly well maintained.

That Mr. Acres thoroughly believes that the shovels gave excellent and efficient service is shown by his following remarks:

> "May I interject a remark? What Mr. McBride says about the shovels is quite correct; the shovel operation was one of the shining exceptions of inefficiency on the Queenston work; the shovel crews did very wonderful work, and I have no hesitation in certifying to the fact. It is what saved the job. I have no criticism to make." Ev. 2804

We do not believe that the excavating units gave the output they were capable of giving, not for the reason of inefficient operation of their crews, for in this matter we find general agreement with the statements made by the witness quoted above and also the statement made by Mr. Acres, but the very manner in which the work was conducted could not help but effect the efficiency of the shovels for the conditions obtaining on the work during the latter part of 1920 and during 1921 resembles what may be termed a "mad rush" to complete the work on time. Such procedure invariably reduces efficiency.

Accepting, however, the statement of Mr. Acres that the shovels did all that could be expected of them, and referring back to his previous statement wherein he shows that had they done what was originally expected of them, the estimate would not have been exceeded. It can only be concluded from his remarks that, in spite of all conditions such as lower efficiency, wage increases, abnormal expenditures for supplies, equipment and plant, the work would have cost little, if any, more than the estimate,

throughout the war period with the efficiency of the equipment in the Italian theatre was fairly well maintained.

That Mr. Jones thoroughly believed that the officers were examined and efficiency serious is shown by his concluding remarks:

> "May I interject a remark? That Mr. Doherty says about the Jovella is quite varying; the Chief Superintendent was one of the finest examiners of instruments of the Department. He was the most keen on his responsibility, the most alert and the most meticulous man, and I have no hesitation in verifying to the best. It is what saved the job. I have no criticism to make."

Mr. Jones

1895

Or do not believe that the examining staff gave the Italian officers any trouble. They were equally as prompt and far more of instrument examiners of high order. For the sake of the record, however, the Italian officers made complaints with the instruments made by the Canadian Wireless and also the instruments made by Mr. Jones, but the very answer is which the Canadian small and high the reflect the efficiency of the officers for the conditions that lay on the work during the latter part of 1917 and during 1918 somewhat was due to turned a "bad power" to complete the work on time. Such problems immediately reduce efficiency.

Everything, however, the statement of Mr. Jones that the Jovella is AT that would be superior of stand, and reflected back to his previous statement showing he knew this back to my done was exceptionally superior at time. The estimate would not have been demanded. It can only be deduced from his remarks that, in spite of all conditions such as lower efficiency, more instruments, shorted repairs for supplies, equipment and plant, the work would have been little,if any, more than the estimate.

if capacities as estimated upon had been realized. This gives a broad idea of the importance which Mr. Acres himself attaches to this matter.

Relation of Output to Estimated Cost

The important bearing that the capacities assumed by the engineers for these shovels had on the estimates prepared by them may perhaps be best observed by referring to Estimate No. 2, wherein is given a "Discussion and Analysis of Cost of Operating Excavation Plant, including Railway". The various items making up the estimated unit cost of excavation are given in a summary at the end of the discussion, and are as follows:

Earth Excavation		Rock Excavation	
1. Shovels	5.30 cts.	1. Shovels	9.02 cts.
2. Locomotives	5.00 "	2. Locomotives	8.53 "
3. Cars	3.90 "	3. Cars	6.62 "
4. Track and Maintenance	4.64 "	4. Track and Maintenance	4.64 "
5. Dump Ex. (Total)	1.83 "	5. Dump Ex.	2.69 "
6. Overhead Trolley	1.87 "	6. Overhead Trolley	1.96 "
7. Bonding	.07 "		
8. Rotary Converters	.99 "	7. Rotary Converters	0.98 "
9. Trimming	.50 "	8. Channelling Expenses	21.46 "
10. Sodding	.50 "	9. Drills	11.63 "
11. Miscellaneous	2.00 "	10. Dynamite	29.74 "
Total	26.60 cts.	Total	97.27 cts.

Dealing first with earth excavation, it is to be observed that items 1, 2, 3 and 5, aggregating over 16 cents of the total estimated unit cost of 26.6 cents are arrived at directly by using the estimated capacity of the shovel as a base. As an illustration, item 1 was made up of a total

It adjudicates an extensive view but from realities. This gives a broad idea of the importance which Mr. Jones himself attaches to his writing.

Relation of Orders 1- Detailed Cost

The important bearing that the adjustments assumed by the secretary for these showing had on the estimates prepared by them may perhaps be best appreciated by referring to statement No. 2, wherein is given a "Tabulation and Analysis of Cost of Operating Laboratory Plant, Including Building". The various items making up the estimated unit cost of laboratory plant are given in a summary at the end of the discussion, and are as follows:

Item Description		Item Description	
1. Sinvale	5.00 rds.	1. Gurgle	5.00 rds.
2. Laboratory	5.00 "	2. Laboratory	5.00 "
3. Ears	5.00 "	3. Ears	5.00 "
4. Press and Stationery .	1.25 "	4. Press and Stationery ...	5.25 "
5. Dump Dr. (Total)	1.00 "	5. Dump Dr.(Total).....	1.25 "
6. Overhead Trolley	1.87 "	6. Overhead Trolley	1.87 "
7. Dredging	.07 "		
8. Entry Conveyers	.17 "	7. Entry Conveyers	0.83 "
9. Trimming	.50 "	8. Dismantling Squares	1.34 "
10. Loading	.84 "	9. Jutlin	1.88 "
11. Miscellaneous	1.00 "	10. Dynamite	12.37 "
Total	22.27 rds.	Total	27.27 rds.

Dealing first with auto mobiles, it is to be observed that items 1, 2, 3 and 5, corresponding over 22 cents of the total estimated unit cost of 22.4 cents were derived at directly by using the estimated capacity of the shovel as a base. In an illustration, item 1 was made up of a total

estimated daily cost for a 225-B shovel of $267.20, plus a total estimated working day cost for a 103-C shovel of $183.95, making a total daily cost for two shovels of $451.15. In turn, this daily cost was divided by the estimated daily output of both shovels, namely, 5,000 yards and 3,500 yards, respectively, or 8,500 cubic yards, resulting in the figure given in the table above, namely, 5.3 cents.

As we have already shown the average efficiency for the 225-B shovel was about 35 per cent. or in other words, 1,750 cubic yards instead of 5,000. The average for the 103-C type in earth was about 22 per cent. or 770 yards instead of 3,500. Therefore, other things being equal, the total cost of $451.15 may be divided by 2,520 to get a comparative figure, which gives us, instead of 5.3 cents per cubic yard, almost 18 cents. Items 2, 3 and 5 would not be increased in the same ratio, but that they would be increased to a certain extent is obvious.

Dealing with rock excavation, the estimated capacity of the shovels affected items 1, 2, 3 and 5.

The remaining items for both earth and rock while indirectly affected were generally arrived at in another way.

Viewing the matter from a different angle and one which will have more appeal to the layman, it is to be observed that on the basis on which the engineers of the Commission estimated, namely, that a 225-B shovel would give 5,000 yards per ten-hour day for 250 working days in a year, it is to be observed that these mammoth shovels would have to dig and load cars lifting the excavated material through a height of 50, 60, 70 and sometimes 80 feet, once every 57-1/2 seconds throughout each ten-hour day for every working day in the month, for ten months in the year. Since the shovels had to be moved and since delay for repairs and hard digging always occur on any job, it is obvious that at times the shovels to keep up their average would have to dig and swing

estimated daily cost for a 222-0 vessel at $247.00, plus a total estimated working day cost for a 222-0 vessel at $223.00, making a total daily cost for both vessels of $471.23. In turn, this daily cost was obtained by the following daily wages of both crewmen, namely, 3.00 yards and 2.00 yards,respectively, or 5.00 cents yards, resulting in the figure given in the table above, namely, 5.0 cents.

As we have already shown the maximum efficiency for the 222-0 vessel was about 92 per cent, or in other words, 3,700 cubic yards instead of 4,000. The average for the 222-0 type in water was about 82 per cent, or 330 yards instead of 3,300. Therefore, during storage during repair, the total cost of $471.23 may be divided by 3,300 to get a comparative figure which gives us, instead of 5.0 cents per cubic yard, almost 14 cents. Thus 2, 3 and 4 weeks may be deducted in the average, but that time could be invested in a certain extent in overhaul.

Dealing with your assertion, the estimated capacity of the dredge affected lines 1, 2, 3 and 4.

The remaining items for both work and pump units individually affected were generally arrived at in another way.

Viewing the matter from a different angle and as regards will have been spent in the Japanese, it is to be observed that on the basis on which the engineers of the Commission estimated, namely, that a 222-0 dredge would give 3,000 yards per two-hour day for 300 working days in a year, it is to be observed that these seasonal dredges would have to dig and load sure lifting the accrued material through a height of 80, 40, 70 and sometimes 30 feet, some study 37-3/2 months instead of two-hour day for every working day in the month, for two months in the year. Hence the schedule had to be based and also also daily for repairs and tugs dragging always every so many yrs. It is believe that at times the dredge is busy by their strange which have to dig and bring

probably in one-half this period of time, or in about every thirty second during the period that they were actually in operation.

The foregoing discussion has been based upon the assumption that the dipper on the shovel would average an eight yard quantity each time. Now this is a theoretical condition which seldom obtains on any work. Under average conditions over long working periods, it will probably be found that an eight yard dipper will average only about six yards per lift. If the excavation is dense and reasonably moist, the full eight yards or more may be realized at times. If the excavation is very wet or in a "soupy" condition, much of the bucket capacity will be lost. Our comparisons are, therefore, based upon what may be termed ideal conditions and for the Chippawa work a great proportion of which was very wet, the dipper capacity per lift would necessarily be reduced, which in turn would affect the output quantity per day.

The comparisons given above relate only to operation in earth, a 225-B shovel in rock operating with a five-yard capacity bucket was estimated by the engineers to give a capacity of 3,000 yards per ten-hour day. For use in our comparisons we have assumed that it was possible on an average to lift a full bucket of earth at each swing, but in rock work, it is impossible to make any such assumption and the most liberal amount that can be allowed per swing would not exceed three yards. On this basis it will be found that in rock the shovels would have to dig and swing on an average of once every 36 seconds, throughout each ten-hour day for every working day in the month, for ten months in the year, if the estimates of the engineers are correct. This discloses even a worse condition than that obtaining with reference to earth excavation. Over long working periods such rapidity of operation would be considered excellent performance for much smaller types of standard steam shovels which only have a fraction of the lift, oftimes only to the top of an

ordinary horse-drawn dump-cart and it is to be remembered that while electric shovels are cheaper to operate than steam shovels they are not so rapidly handled.

Summary

It is a very difficult task to make an exact analysis of what Estimate No. 2 should have amounted to on the basis of actual output as it is obviously impossible to know just every detail that the engineers of the Commission had in mind when they were preparing their estimate. We have been able, however, to arrive at approximate prices for earth and rock excavation which would have represented more nearly those which the engineers should have employed in revising Estimate No. 2 when subsidiary Estimates Nos. 2-A and 2-B were prepared and, in our opinion, a man of practical experience would have used much the same figures even when Estimate No. 2 was prepared in 1917.

The unit prices we have arrived at indicate most clearly that both earth and rock excavation was considerably underestimated. Correcting the estimates in accordance with these units for earth and rock excavation in the canal, forebay, screen house and power house excavation, and making other necessary adjustments to bring the estimates into conformity with our present analysis we arrive at a figure of approximately $6,000,000 which we believe fairly represents the amount by which the engineers underestimated the cost of work. This means that Estimate No. 2 and its subsequent revisions Nos. 2-A and 2-B should have been about $39,721,000 instead of $33,721,000, as shown on page 279 of this report, when corrected for quantities as built.

Rush Schedule.

Now, so that our analysis of this subject will be properly understood and the significance of the matter placed within easy grasp, we will deal with two items of extra expenditure which arose entirely out of the error made in respect to estimates which in turn affected the planning of the work. The subject we have in mind is the question of increased cost due to rush schedule, which was inaugurated in the latter stages of the work and which subject is closely related to the inefficiency of night operations and the greatly increased working force employed during this period.

As previously pointed out, the report prepared by Messrs. Stuart and Kerbaugh was made in September, 1920. In February, 1921, Mr. Gaby, Chief Engineer, presented a report to the Commission asking for appropriations based on the Stuart and Kerbaugh report to which he added an extra contingency item in addition to contingency items of 10 per cent. already included in the Stuart and Kerbaugh estimate. In this connection, Mr. Gaby was asked:

Q.- Did you think when you presented your estimates that that item of contingencies was too low? Is that why you added 10% more to the contingencies? Ev. 4503

A.- I would not say that I considered it too low, but in my own general judgment and to be on the safe side I added 10% to the cost of the canal construction.

The contingency amount provided by Messrs. Stuart and Kerbaugh amounted to $3,634,611.00 and though the evidence is not quite clear as to the additional contingency amount provided by Mr. Gaby, it appears to have been after providing for interest a net amount of between $2,000,000 and

Jack Kyoshio.

Now, as this new analysis of this subject will be primarily concerned with the significance of the matter placed within my trust, we will deal with the items of work expenditure which have previously met at the first such in response to evidence which is now attacked the adequacy of the work. The subject we have in mind is the question of increased cost due to rush schedule, which was investigated in the latter stages of the work and which subject is closely related to the inefficiency of night operations and the greatly increased wastage from which we suffer during this period.

In previous [illegible] the Grand Jury by Senator [illegible] and Darkness was made in September, 1920. In February, 1921, Mr. Gaby, Chief Engineer, presented a report to the Committee having to cryptic-[illegible] based on the Power and Economy report to which he added my entire investigation in addition to contingency items of 12 per cent, already included in the Grand and Darkness estimates. In this connection, Mr. Gaby was asked:

Q.- Did you tell them when you presented this report that that item of contingencies was the same? He did not you added 12% more to the contingency?

A.- I would not say that I considered it too low, but in my general judgment and to be on the safe side I added 12% to the cost of the usual contingencies.

The contingency amount provided by Gaby. There had Darkness amounted to $2,424,411.27 but about the estimate is not quite clear as to the additional contingency amount provided by Mr. Gaby. It appears is that Gaby after providing the Darkness a sum amount of between $2,000,000 and

$2,400,000. Dealing with the matter further Mr. Gaby stated:

> Now there is one thing I want to draw to your attention that had materialized between the time of making this report (Stuart and Kerbaugh), which you will know provides for a date of completion in November (1921). The Commission had decided to go on with the dredging operations as recommended here, and in view of the fact that we had a tremendous rush schedule to be carried on, I considered that an additional contingency item was necessary. Ev. 4504

Q.- Then part of the consideration which led you to add this additional 10% was a decision to rush that work?

A.- Yes, and deal with it by September 1st, 1921.

Mr. Gaby was then asked if he received written instructions from the Commission regarding the rush schedule and replied:

> "It would come in an instruction or authorisation to go on with arrangements for the rental of the dredging equipment and to carry on the suggestions of completing the work by September 1st, 1921." Ev. 4504

In passing, it is of interest to note that the Commission, judging by Mr. Gaby's evidence, dealt with the extra expenditures for the rush schedule amounting to millions of dollars in a very casual way, and we do not know of anything which shows that the Government's attention was particularly directed to this decision which involved so great an additional expenditure. Continuing, the evidence reads as follows:

Q.- What was the object of completing by September 1st, 1921?

A.- In order to meet the increased demands for power in the fall of 1921.

Q.- What increased demand was there in the fall of 1921?

A.- There was one thing of course, the load of the Toronto Street Railway, it was being taken over by the City of Toronto and that was one; but our general estimates showed that we would

have an enormous increase in our load which we could not take care of any other way than by the Queenston-Chippawa Development or by purchase elsewhere. Ev. 4535

THE CHAIRMAN: You might have purchased elsewhere?

A.- No, in 1920 it was a doubtful thing; but on account of the slackening off of industrial conditions, in the Spring of 1921, we were able to buy power that we could not have bought in 1920.

COMMISSIONER ROSS: Your program was set for September?

A.- Yes.

Q.- How nearly did you complete that program?

A.- We slowed down in July; but I would say that with the exception of the equipment which, on account of the fire destroying the plant in the power house, was lost, we would have practically completed the work at that time.

(It should be noted here that the Cooper estimate contemplated the operation of the first two units in the fall of 1922 or about one year later.)

Q.- Why did you slow down in July 1921?

A.- In May I kept getting the cost reports, and in June, and we noted that the estimated unit costs were rising and instructions were issued to prepare reports at once in connection with this matter, in detail. And in view of the fact that other arrangements could be made to continue the Power Company's contract beyond September, 1921, further, in view of the fact that we could probably obtain a supply of power from these other companies, which was not known in December and January, 1920, and in order to conserve and keep costs down to the minimum, we decided it would be better to cut out the inefficient night shift." Ev. 4536

On October 7th, 1921, Mr. Gaby prepared what may be termed a justificatory report addressed to Sir Adam Beck, which set forth the reasons for increases over and above the Stuart and Kerbaugh report of September, 1920. In it several significant statements are made. Referring to the inefficiency of night shift operations, it states:

"As an illustration of this - in the month of August last the

working force was reduced from 8,000 to 3,000 men; direct labour costs dropped approximately 37%, and the average rock production per shift increased about 26%. These economies were obtained while the work was not fully systematized under the new working conditions and while the wage reduction only applied to 70% of the working days of that month." Ex. p.81

"Wholesale dismissals during the night shift on account of misdemeanors in connection with the illicit traffic caused a large expenditure in operation and consequent disruption in organization."

"If the re-organization had taken place on February 1st instead of in August last the estimated saving in labour costs alone would have been $3,418,000."

Again:

"Following is a summary of increased costs due to the rush schedule:

Labour Costs	$3,418,000	
Freight and Exchange	1,100,000	
Stores and repair parts	1,000,000	
Concrete plants	425,000	Ex.
Extra Tramcage	352,000	p.82
Extra Fuel Costs	100,000	
Extra Cost of Sand	100,000	
Auxiliary Service	300,000	
Total ...	$6,795,000	

The general conclusion is that the estimates made previous to July of last year were not sufficient to absorb the set-back due to the strike of last year and the resultant wage increase and abnormal requirements of the double shift schedule.

Two main items which contributed to the failure of these expectations were:

1. The impossibility of making the night shift operations as efficient as the day operation, and

2. The unavoidable delay in getting the steam equipment into operation and its failure to make good as compared with the electrically driven plant."

So according to Mr. Gaby's own statement, the rush schedule

increased the cost by almost $7,000,000.

We have already shown that part of the sum provided by Mr. Gaby for contingencies was to cover the anticipated extra cost of the rush schedule. The rush schedule cost, however, according to Mr. Gaby's statement, $6,795,000, and it was not continued for so long a period as originally intended. Even if we assume that the whole sum of $2,400,000 was provided for this purpose alone, we find that it was only a little more than one third of the additional expenditure involved. This comparison shows that, after three years' experience on the work and of the conditions under which it was being done, the engineers estimated that less than two and one-half million dollars was a sufficient sum to allow for work which cost over six and three-quarter millions.

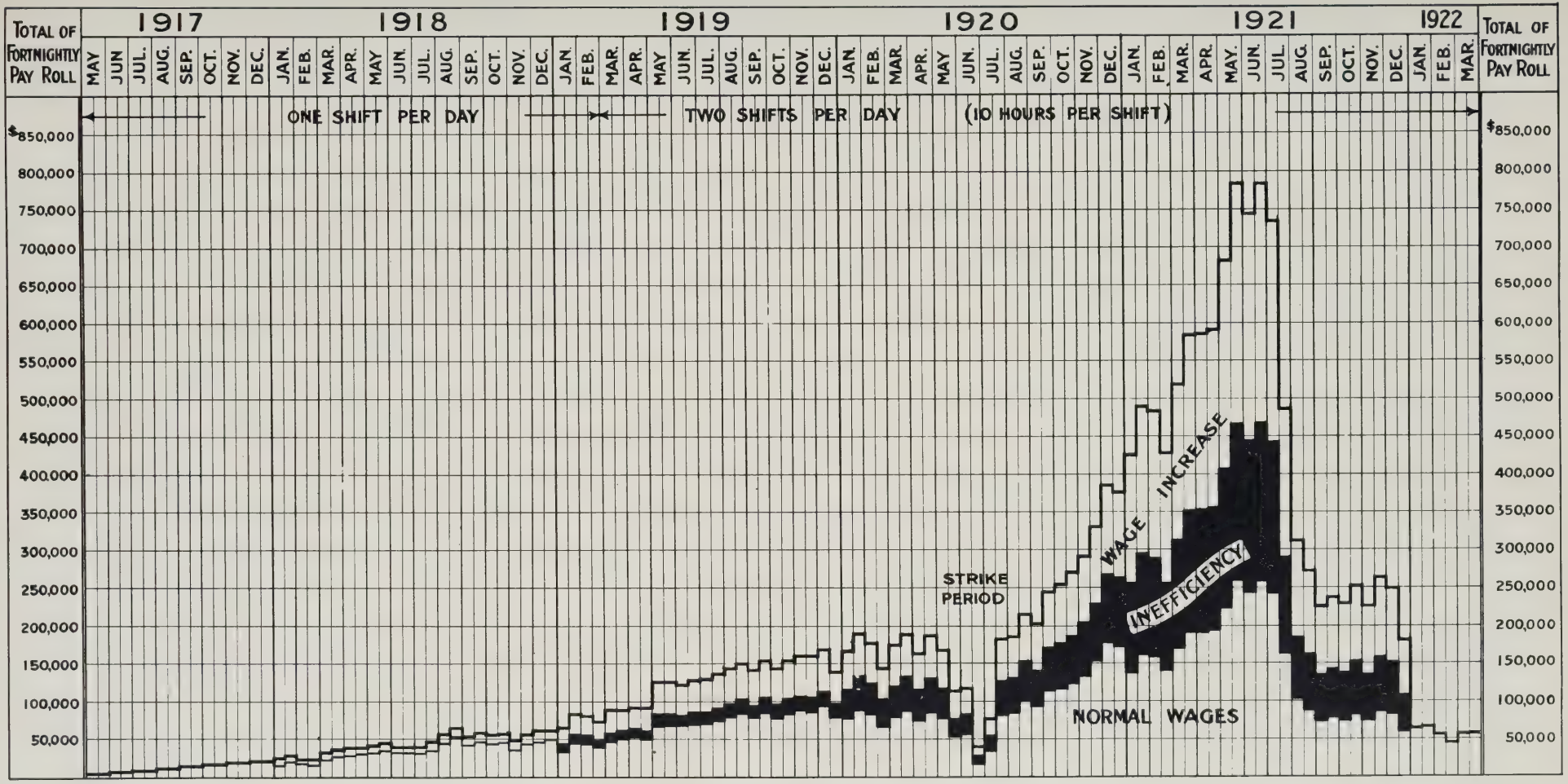
The question arises as to whether the Commission was justified in inaugurating a rush schedule, necessitating such large additional expenditures, when their estimates had already been greatly exceeded. Whatever the facts may be in reference to the Commission obtaining power from sources other than the Queenston-Chippawa Power Development, it evidently became alarmed at the ever-increasing expenditure, for Mr. Gaby points out that the rising costs, among other things, had a definite bearing on the Mr. decision to "cut out the inefficient night shift". 4505

There is another factor, bearing on the rush schedule, which undoubtedly gave rise to extra costs which were also of considerable importance. We have already shown that a decided drop occurred in the cost of labour and materials under ordinary commercial conditions during midsummer

and the latter part of 1920. Examining the records of the Commission, we find that no decrease in wages occurred until mid-summer of 1921. As already shown, the first half of 1921 was the period when the work on this development was at its height. We have it from Mr. Gaby's statement that in August of 1921, the working force was 8,000 men. It is apparent, therefore, that rushing the work during the period of maximum wage rates must have had the effect of pyramiding costs to an enormous extent.

Mr. Francis has prepared charts which show this condition in a most graphical manner. We include herewith as page 318 chart showing analysis of wage expenditures, on page 319 chart showing the number of men employed, and on page 320 the total payroll and average rate per man hour. Comparing these charts, it will be noted that the maximum of wage increase and inefficiency obtained during the period that the greatest working force was employed, and it naturally follows, therefore, that the total payroll during this period was comparatively higher than at any other stage of the job. The monthly wage expenditure had increased gradually from the commencement of operations in 1917 up until the latter part of 1920, when the monthly payroll amounted to $500,000, and in the short space of nine months the monthly expenditure in respect of wages had reached almost $1,500,000 per month. In like manner the average number of men employed during the latter part of 1920 was between 2,000 and 2,500. By June of 1921 the force had been increased to well over 8,000.

The last chart referred to, namely that on page 320, shows the fluctuation in the average rate per man hour. On the 15th of May, 1920,



NOTE –

TOTAL WAGES PAID UP TO DECEMBER 31ST, 1921 . . . . . $ 19,896,657.53

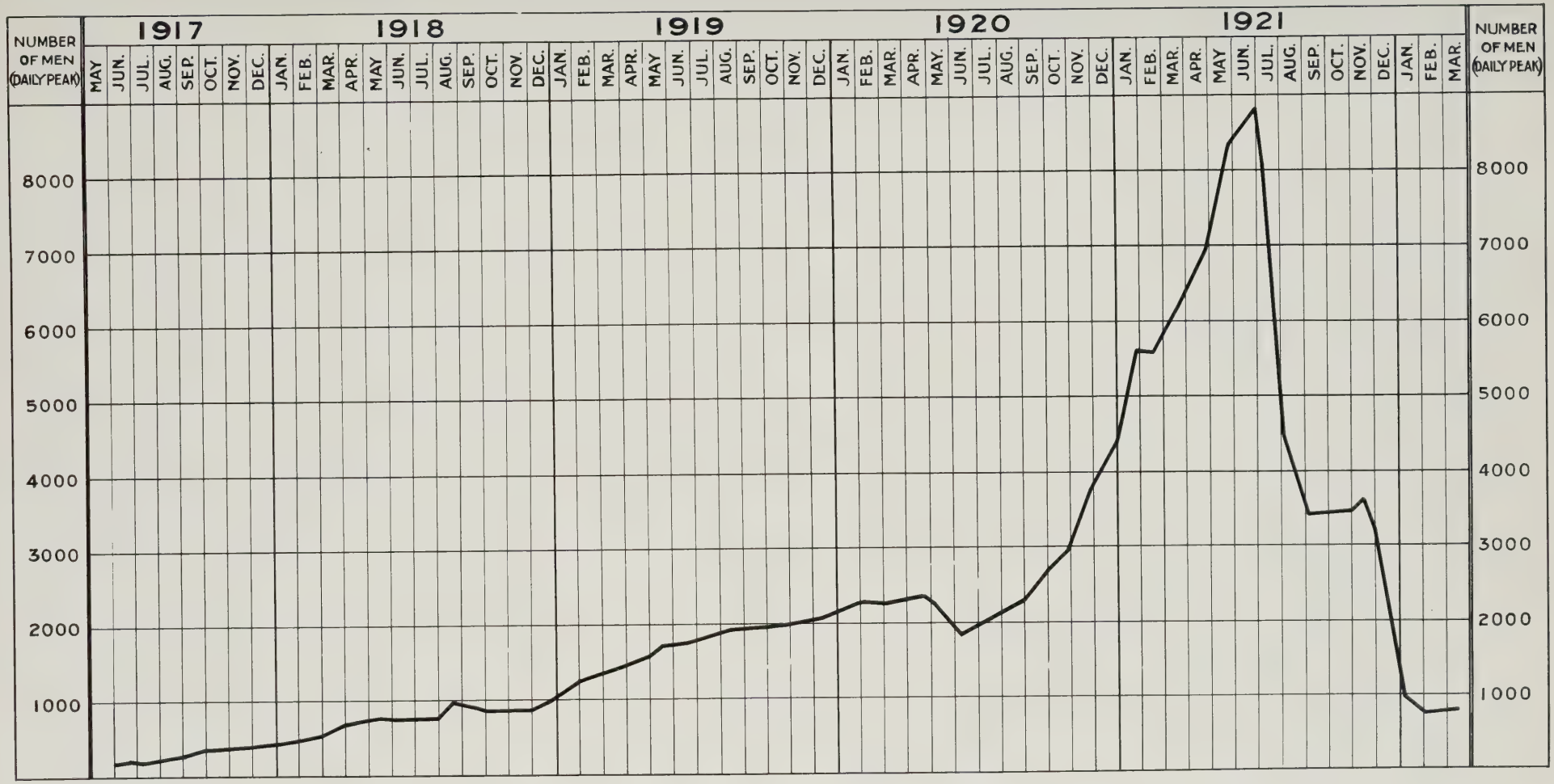
AMOUNT DUE TO WAGE INCREASE . . . $ 6,943,295.37
AMOUNT DUE TO INEFFICIENCY 4,423,142.96
AMOUNT OF NORMAL WAGES . . . . . 8,530,219.20 $ 19,896,657.53

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
QUEENSTON-CHIPPAWA POWER DEVELOPMENT

ANALYSIS OF WAGES EXPENDITURE

Toronto, July 27th., 1923. Made by S.R.W., Checked by W.J.F.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS



Note:

The curve has been plotted by taking the maximum number of men engaged at one time during every month.

HYDRO-ELECTRIC INQUIRY COMMISSION

W. D. GREGORY, CHAIRMAN

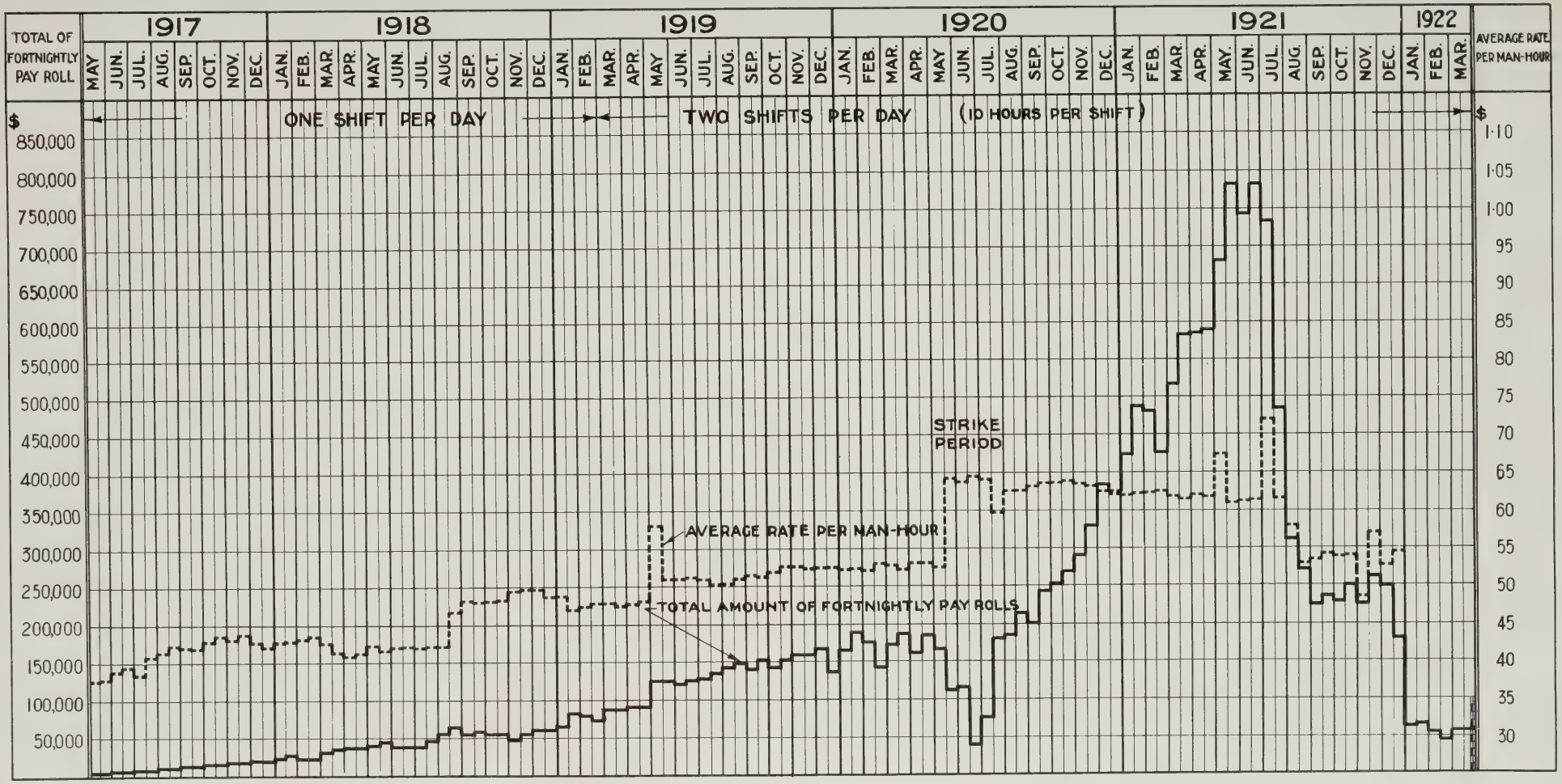
QUEENSTON-CHIPPAWA POWER DEVELOPMENT

NUMBER OF MEN EMPLOYED (DAILY PEAK)

Toronto, July 27th, 1923. Made by [illegible], Checked by [illegible]

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS



Note:

The curve marked "Average Rate per Man-Hour" is obtained by dividing the total number of man-hours into the amount of the corresponding pay roll.

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
QUEENSTON-CHIPPAWA POWER DEVELOPMENT

TOTAL PAY ROLL AND AVERAGE RATE PER MAN-HOUR

Toronto, July 27th, 1923. Made by [illegible], Checked by [illegible]

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

the average rate per man hour increased from 55½¢ to about 65¢ per man hour, and continued at about this rate until the end of April, 1921. During May and July of the period following, the average rate actually rose to 68 and 72¢ per man hour, thereafter dropping during the remainder of 1921 to an average level of 55¢.

Perhaps the most remarkable thing about the whole construction procedure on this job was the tremendous amount of rock excavation moved during the year 1921. This excavation was actually commenced about mid-summer of 1918 and two and one-half years after, namely the end of 1920, less than 40 per cent. had been excavated, the balance, being 60 per cent., was all excavated during the year 1921. It is apparent, therefore, that the extra cost involved through rushing the work at this time and in the manner and by the methods employed by the Commission, increased the cost of the work very greatly and, in our opinion, little if any of this expenditure would ever have been incurred had the work been conducted in an orderly fashion from the commencement of operations or even during the years 1919 and 1920. Therefore, the amount of money involved in this respect can only be regarded as an economic loss not chargeable against any of the items before discussed in this report, and may be most clearly described as "true excess cost".

In arriving at a figure which may be said to fairly represent in dollars and cents this excess cost, the figures submitted by Mr. Gaby and also those given by Stuart and Kerbaugh in their report of December 13th, 1921, are interesting. As shown, Mr. Gaby places the amount attributable to rush

the average wide gap was more increased from 8d(p) to about 10p per week
Gary, and remained at about this rate until the end of April, 1921.
During the year 1921 at the Jarrow Shipyard, the average rate fluctuated
from 9d and 7d per week, somewhat dropping during the recession
of 1921 to an average level of 5d(p).

Perhaps the most remarkable thing about the whole construction
procedure is that job was the responsibility mainly of two managing men
during the year 1921. Their experience was totally unsuited about job-
management of this kind and the job was well-nigh above either, although the end of 1921,
less than 60 per cent. had been completed, the Dockers, being 40 per cent.,
was still practically [illegible] 1921. It is apparent, therefore, that the
extra men employed through raising the wage at this time had to the manner
and by the methods employed by the Dockers, increased the cost of the
work very greatly and, in our opinion, little if any of this expenditure
would have been incurred had the work been constructed in an orderly
manner from the commencement of operations or even during the period 1919
and 1920. Therefore, the amount of money incurred in this respect was only
an reminder as to necessary lack our shipyards optimal map or the lines
before diverted to this report, and not to most clearly described as "time
wasted work".

It appears as a matter which may be said to fairly represent
in Britain and again this overall wage, the figures mentioned by Mr. Daly and
also those given by Frazer and Gribbonge in their report of February 1920, 1921,
are interesting. As above, Mr. Daly places the average overtime in the

schedule at $6,795,000, but his analysis does not take into account the pyramiding of costs due to the bulk of the work being done during the period of highest wage rates and least efficiency, which matter we believe was of almost equal importance.

We have previously referred to the fact that the total wages on the work to December 31st, 1921, were about $20,000,000 made up according to the Commission's figures of $7,000,000 chargeable to wage increases, $4,500,000 chargeable to inefficiency, the balance $8,500,000 being on the basis of 1917 rates. It is interesting to note just how those amounts are arrived at by years, and we submit as page 318 of this report, a chart prepared by our Consulting Engineer and hereunder a table prepared from this chart showing the yearly amounts chargeable to wage increases, inefficiency and wages under 1917 conditions.

Analysis of Wages Expenditures.

Year	Amount due to Wage Increases	Amount due to Inefficiency	Amount of normal wage	Total Wages	
1917	-	-	$ 213,000 (100%)	$ 213,000	
1918	$ 194,000 (18%)	-	882,000 (82%)	1,076,000	W.J.F
1919	958,000 (32%)	$ 359,000 (12%)	1,637,000 (56%)	2,954,000	M-S
1920	1,463,000 (30%)	1,157,000 (24%)	2,246,000 (46%)	4,866,000	
1921	4,328,000 (40%)	2,907,000 (27%)	3,553,000 (33%)	10,788,000	
	$6,943,000	$4,423,000	$8,531,000	$19,897,000	

First, it will be observed that of the $19,897,000 wages over half, or $10,788,000 was expended in 1921, out of a total working period of well over four years. Secondly, the amount spent in 1921 was more than twice that spent in 1920 and nearly four times that spent in 1919. The effect of

such expenditures during highest wage rates and least efficiency, caused a pyramiding in costs which is quite apparent. In another place we have shown that wages dropped and efficiency increased under commercial conditions in 1920, not so on this work however. On a percentage basis both wage rates and efficiency were greater in 1921 than in 1920.

Using Mr. Gaby's figure of nearly $7,000,000 and correcting this for costs which may be said to be justified and adding thereto an amount in respect of the pyramiding of costs and other factors throughout the construction period, we have a figure on the order of $9,000,000 or $10,000,000 as representing a conservative estimate of excess abnormal expenditure chargeable against our figure of $26,480,000.

Summary

Summing up, therefore, our discussions of the various amounts totalling the $26,480,000 before referred to, we have the following:

Amount chargeable as underestimated	$6,000,000	
Amount chargeable as excess cost, (say) ..	9,000,000	$15,000,000
Balance		$11,480,000

This balance, we believe, fairly represents what may be termed justifiable abnormal expense brought on by conditions over which the Commission had no control and which were unforeseen when estimates were prepared.

The figure of approximately $11,000,000 given above does not by any means represent the total of expenditures entering into this work, chargeable as justifiable abnormal expense, for it must be remembered that the sum of over $4,000,000 given as Item 4, on our balance sheet forming

page 272 of this report, includes charges all of which were largely inflated due to increased cost due to war conditions. For instance, the indirect cost attributable to fires would probably have been only half what it was had 1917 conditions prevailed. It is also probable that the strike would never have occurred, and the loss charged against this account would not have been experienced. Unwatering charges would probably have been about one-half what they actually were. Overhead expenses on the above items would probably have been reduced in the same ratio. It may be concluded, therefore, that the sum of $11,000,000 must be increased by about $2,000,000 before a truly representative figure may be arrived at as a total justifiable abnormal expense on this work, thus giving as a total approximately $13,000,000, and adding to this the amount of about $2,000,000 allowed in the estimates, the total justifiable abnormal expense would appear to be $15,000,000 or $16,000,000.

In like manner the item of $4,000,000 also includes costs caused by the manner in which the work was conducted and these should be added to our figure of $9,000,000.

Section 44

OTHER LOSSES

Fires.

An examination of the records of the Commission, show that a good policy was adopted in reference to insuring the works during the period of their construction, and the amounts collected by the Commission from the insurance companies exceeded the premiums paid. It would also appear that the amount so collected adequately covered the direct loss due to the destruction of buildings and equipment by the fires that occurred on the work.

On any construction work, the direct losses may be covered by insurance, but in the event of fire, there are indirect losses which are not

page 325 of this report, includes amounts all of which were largely retained and be liquidated over the ex war conditions. The Ministry, in-fact, was existing, in fact, only because of the war conditions. It is also probable that the Ministry would never have existed in peacetime conditions. It is also probable that the debts would never have accrued, and the last larger amount, viz. $[illegible] would not have been expended. Temporary advances would probably have been made so that they actually were. Temporary expenses in the early times would probably have been retained by the same rules. It may be mentioned, however, that the sum of $11,000,000 could be accounted for under $[illegible] under a total representative figure may be arrived at as a total "multiplied abnormal expenses on this work", thus giving as a total approximately $[illegible], and adding to this the amount of about $2,000,000 allowed in the estimates, the total "multiplied abnormal expense" would amount to $[illegible] or $13,000,000.

By like manner the item of $4,000,000 also included years ending by the manner in which the work was conducted and this should be added to our figure of $13,000,000.

Section 17

[illegible]

Plant.

An examination of the records of the Commission, when that a good policy was adopted in reference to insuring the works during the period of their construction, and the amounts collected by the Commission from the insurance companies proceeds the premium paid. It would also appear that the amount so collected considerably exceeded the direct loss due to the destruction of half-[illegible] and equipment by the fires that occurred on the work.

In my investigation work, the direct losses may be summed up [illegible] insurance, but to the work at Ile, there are [illegible] losses only the [illegible]

and cannot be covered by insurance policies. The Queenston-Chippawa work experienced several fires of varying degree, but the two most important are those which occurred in the power house at Queenston and the main transformer station at Montrose. The fire at the power house disrupted operations for some little time, which naturally caused a loss which was not recoverable. The amount was small, however, and on a work of this magnitude has little or no significance.

The fire at the Montrose sub-station was, however, of much greater importance, and while direct losses were recoverable from the insurance companies, the indirect loss which occurred was of very considerable importance. It was through this station that all power operating the transportation system was handled, and the fire which occurred greatly disrupted the whole work for some little time. It is very difficult to state just what this loss amounted to, but it has been stated to us by Mr. Acres in evidence that, in his opinion, a sum of $1,000,000 would probably represent the economic loss which resulted from this occurrence. These figures find support in an estimate prepared by Messrs. Stuart and Kerbaugh and in all probability is as near the mark as can be ascertained at this time. This is a matter which was wholly unforeseen and against which no definite provision could be made unless it be assumed that it came under the general heading of contingencies.

Strike. On a work of this size, a disruption of working conditions is a matter which results in indirect costs the magnitude of which it is

difficult to ascertain. In 1920 a strike occurred on the Queenston-Chippawa work which lasted about a month and which undoubtedly gave rise to an economic loss of some considerable proportion. The total or partial closing down of a work of this size, necessitating to a large extent the reorganization of the working force when operations are again commenced, and having regard to the fact that fixed charges on equipment, etc. are continuing during the period of the strike, results in losses which are very real.

Estimates made by our Consulting Engineer and others on this matter would indicate that the economic loss in this respect might vary from one-half million to as much as one million dollars. Stuart and Kerbaugh, in their report of 1921, placed the figure "conservatively" they state, at $613,000. For the purpose of this report, we think this figure may be well accepted as a measure of the loss which occurred in this respect. This amount cannot properly be included as an expense which could be foreseen, unless, like the loss due to fires, it be considered as coming under the head of contingencies.

Unwatering Costs.

The total cost of unwatering, as per figures submitted to our Consulting Engineer by the Commission, amount to something over $1,700,000. As we have already shown, the information in the hands of the Commission before Estimate No. 2 was prepared indicated that the earth overburden was in a very saturated condition and further indicated that this condition was not entirely due to ground water, but that running springs would be encountered as the work was opened up, together with quick sand, gas pockets, etc. An analysis of Estimate No. 2 shows that some provision was made in respect of

materials in warehouse. In 1929 a strike occurred on the Jackson-Chippewa were with lasting effect: a merry and which commercially gave rise to an economic loss by some thousands of dollars. The usual or partial closing down of a work of this size, necessitated in a large extent the overcrowding of the working force whose qualities are well known, and having regard to the very high school economic or expenditure, etc. the maintenance of the payroll of the strike, provide is indeed which are very real.

Reference made to the Committee Delivery and Volume on duty matter would indicate that the economic loss in this department which very from non-fall without to be such as the million dollars. Direct and indirect, in stay repair of 1929, I cannot see any reasonable justify the strike, at $20,000. For the payroll of said strike, at least the time they do well consider as a measure of the loss value measured in this product. This amount cannot properly be included as an expense which should be increased, like the loss due to fire, it be considered as merely adding the level of overhead.

Demurrage Loss.

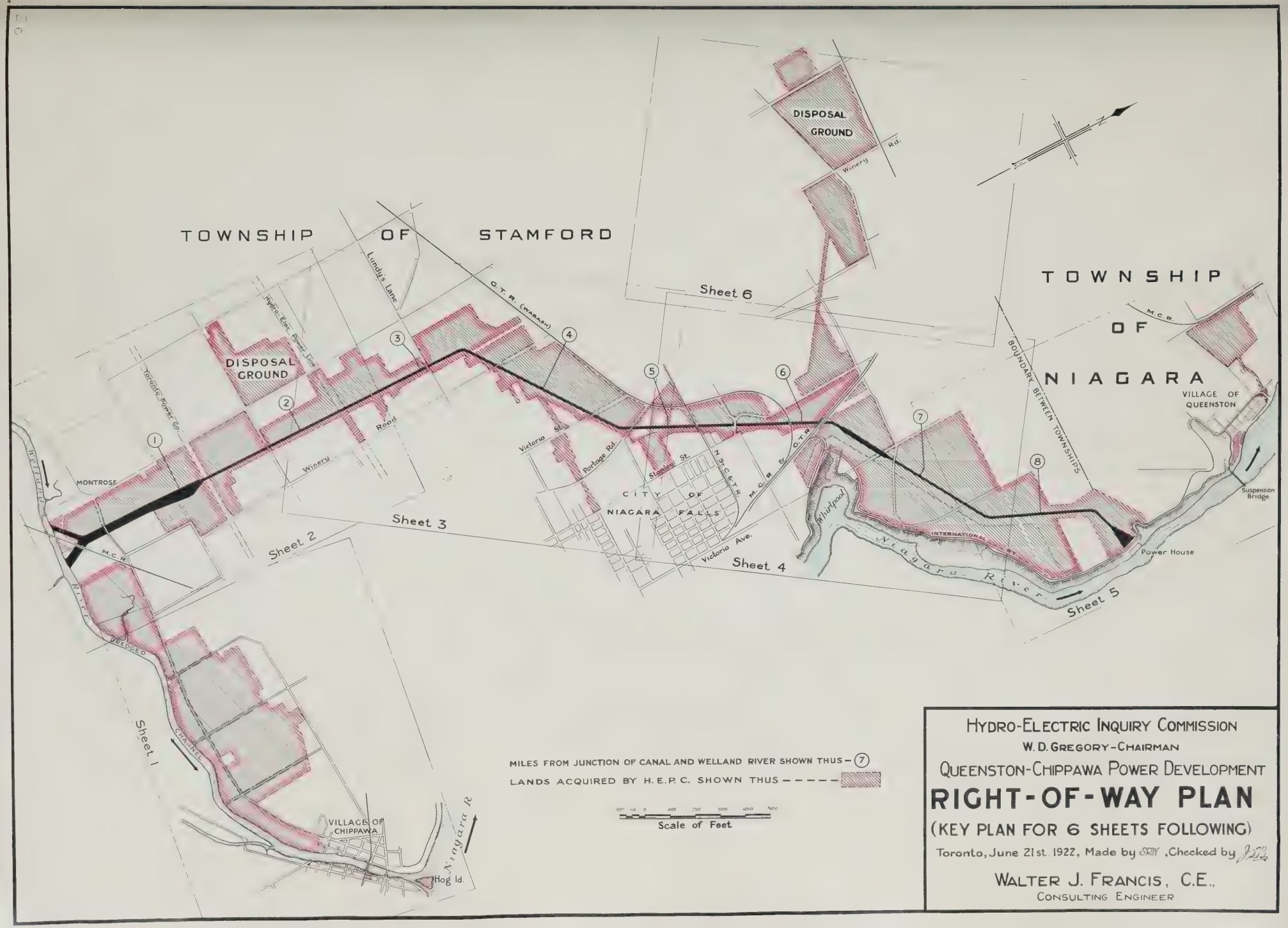
The total cost of warehousing, as per figures submitted to our Transportation Department by the Commission, amount to approximately $4,250,000. as we have already shown, the information is the basis of the Commission Report Exhibit No. 2 was prepared indicated that the work performed was in a very satisfactory condition and further indicated that the condition was due solely due to general wear, but that greater crews would be necessary at the very low rate paid, together with extra work, due penalty, etc. in consideration of Exhibit No. 2 alone that some preliminary expense is required at

unwatering, and for earth and rock excavation there is an item shown as "Miscellaneous and pumping, and other accounts". The provision for earth amounts to about 1.05¢ per cubic yard and for rock about 1.8¢ per cubic yard. Apparently these charges are intended to cover other things than unwatering, but assuming that they may be all charged for unwatering, we find on the basis of yardage that the total sum allowed is something under $200,000. We feel that, knowing the conditions as they did, the amount allowed was much too small.

In our analysis we have allowed as an extra cost the sum of $1,250,000 in respect of unwatering. This is arrived at by allowing the sum provided in Estimate No. 2 in respect of earth and rock excavation and a reasonable amount in respect of unwatering charges for the intake and other parts of the work. Now, while $1,250,000 is an excess cost over the estimate and may indeed be in excess of the amount justified, we are using it as a justifiable excess expenditure for the purpose of this analysis.

Right-of-Way purchased, compared with Right-of-Way estimated upon.

Our Consulting Engineer has prepared a report entitled "Chapter J - Quantities, Right-of-Way" in which a great deal of detailed information is given in reference to quantities and prices paid by the Commission for the ground purchased by them in connection with the right-of-way of the Queenston-Chippawa Canal. We include herewith, for the purpose of illustration, as page 328, a general right-of-way plan. In addition to this plan, Mr. Francis included, as pages J-12 to J-17 of his report mentioned above, plans showing the parcels of land purchased, in greater detail.


TOWNSHIP OF STAMFORD
TOWNSHIP OF NIAGARA
DISPOSAL GROUND
DISPOSAL GROUND
Winery Rd.
Lundy's Lane
Hydro-Elec. Power Line
Toronto Power Co.
Winery Road
G.T.R. (WABASH)
Victoria St.
Portage Rd.
Stanley St.
N.S.C.&T.R.
M.C.R. & G.T.R.
Victoria Ave.
CITY OF NIAGARA FALLS
Whirlpool
INTERNATIONAL RY.
Niagara River
BOUNDARY BETWEEN TOWNSHIPS
M.C.R.
VILLAGE OF QUEENSTON
Suspension Bridge
Power House
MONTROSE
M.C.R.
WELLAND RIVER
DREDGED CHANNEL
VILLAGE OF CHIPPAWA
Hog Id.
Niagara R.
Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sheet 5
Sheet 6
1
2
3
4
5
6
7
8
MILES FROM JUNCTION OF CANAL AND WELLAND RIVER SHOWN THUS — 7
LANDS ACQUIRED BY H.E.P.C. SHOWN THUS
Scale of Feet
HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY - CHAIRMAN
QUEENSTON-CHIPPAWA POWER DEVELOPMENT
RIGHT-OF-WAY PLAN
(KEY PLAN FOR 6 SHEETS FOLLOWING)
Toronto, June 21st. 1922, Made by SRW, Checked by J.F.
WALTER J. FRANCIS, C.E.,
CONSULTING ENGINEER

As stated elsewhere in this report, Estimate No. 1, while only providing for an immediate installation of 100,000 horse-power, provided a canal capacity and other works for 300,000 horse-power. We submit hereunder a table compiled from Estimate No. 1, showing the various items then figured upon:

	Quantity	Unit Cost	Total Cost
Canal in Earth (100,000 h.p.)	90 acres	$150.00	$13,500.00
Canal in Rock (300,000 h.p.)	280 acres	500.00	140,000.00
Regulating Flume (300,000 h.p.)	140 acres	500.00	70,000.00
Whirlpool Storage (300,000 h.p.) ...	16 acres	150.00	2,400.00
Whirlpool Storage (300,000 h.p.) ...	22 acres	150.00	3,300.00
Forebay (300,000 h.p.)	5 acres	500.00	2,500.00
Total	553 acres	$419.00	$231,700.00

In Estimate No. 2, which provided for 300,000 horse-power installation, the sum of $500,000 was allowed for right-of-way. Estimate No. 2-A is in effect a revision of No. 2 and provides for an increase in capacity from 300,000 horse-power to 500,000 horse-power. The total of Estimate No. 2-A is arrived at by adding certain sums for extra work to the total of Estimate No. 2, but as no extra sum is provided in Estimate No. 2-A for right-of-way, it is presumed that the same amount was allowed as in Estimate No. 2, namely $600,000. Estimate No. 1 was based on a canal 42 feet wide. Estimate No. 2-A was based on a canal 6 feet wider, but the sum allowed for right-of-way in Estimate No. 2-A was over 2½ times greater than the amount allowed for right-of-way in Estimate No. 1.

An absent dismantling in this report, Instance No. 1, while only providing for an Overall Overhaul value of [illegible] horsepower, provided a model regarding the return value for [illegible] horsepower. We behold horsepower a value analyzed from Table 1a No. 1, showing the various items that figured again.

Quantity	Unit Cost	Total Cost
Chest 1a Lards [illegible] hp.) ..... [illegible] cores	[illegible]	[illegible]
Chest 1b Rock (3[illegible],[illegible] h.p.) ..... 2[illegible] cores	[illegible]	1[illegible],[illegible].[illegible]
Replicating Piano ([illegible],[illegible] h.p.) .... 1[illegible] cores	[illegible].[illegible]	[illegible],[illegible].[illegible]
Bridgeport Storage ([illegible] h.p.) ... 1[illegible] cores	[illegible]	[illegible],[illegible]
Bridgeport Storage ([illegible] hp.) ... [illegible] cores	[illegible]	[illegible],[illegible].[illegible]
Forklift ([illegible] hp.) ..... [illegible] cores	[illegible]	[illegible],[illegible].[illegible]
[illegible] ..... [illegible] cores	[illegible].[illegible]	[illegible],[illegible],[illegible].[illegible]

In Instance No. 2, value provided for [illegible] horsepower horizontally, the sum of [illegible] was allowed for right-of-way. Instance No. 3-A is in effect a variation of No. 2 and provides for an increase in capacity from [illegible] horsepower to [illegible] horsepower. The value of Instance No. 3-A is arrived at by adding overall cost for [illegible] to the total of Instance No. 2, but as we review and it appeared in Instance No. 3-A for right-of-way, it is presumed that the same amount was allowed as in Instance No. 2, namely [illegible]. Instance No. 3 was based on a normal 12 type rule. Instance No. 3-A was based on a usual 8 foot rule, but was allowed for right-of-way in Instance No. 3-A was over 2[illegible] times greater than the amount allowed for right-of-way in Instance No. 2.

Our Consulting Engineer, on page J-7 of his report, states:

"The properties purchased may be said to consist of about two hundred parcels of land containing 3,540 acres. Of this amount, 3,518 acres were parts of original farm lots and were purchased at an average price of $377.00 per acre. The balance of the property was in town and village lots and consisted of 5,030 lineal feet frontage, at an average purchase price of $13.10 per lineal foot. The total cost of the properties purchased is $1,391,876.00."

When we sum up this information we find that, though the canal as constructed is only six feet wider than the canal as proposed in Estimate No. 1, the Commission purchased more than six times the area of land provided for in Estimate No. 1. We also find that the total cost of the land purchased exceeded the amount allowed in Estimate No. 2-A, which was for a canal of the width as at present constructed, by almost $800,000.00, or 57%.

It is obvious that the Canal, as at present built, requires only a comparatively small fraction of the lands that have been purchased. Mr. Francis, in commenting upon this matter on pages J-19 and J-20 of his report, states:

"It will be noted ... that on the westerly side of the canal much more land was acquired than the immediate needs of the Queenston-Chippawa Power Canal warrant. It has been explained to us by the engineers of the Hydro-Electric Power Commission that these lands were procured because it was considered advisable to do so in order to provide sufficient right-of-way for two other canals parallel with the present one."

But the engineers of the Commission had the greater development in mind when Estimate No. 1 was prepared, for Mr. Gaby stated in evidence before us that:

".... under the original estimate we contemplated purchasing a great deal more right-of-way than was necessary for the 100,000 h.p. development or 200,000 h.p."

The Commission Delivery, paragraph 47 of his report, states:

"The possibility [illegible] may be said to consist of about two hundred percent of land containing 3,960 acres. Of this acreage, 3,213 acres were parts of original Ship Yard [illegible] at an average price of $277.00 per acre. The balance of the property was in this and adjacent Ship and amounted to 3,[illegible] Final Sum Decision, at an average purchase price of $17.17 per final acre. The total cost of the properties purchased is $1,291,896.00."

When we sum up this information we find that, through the usual or customary is only six days after the usual be presented in Congress Jan. 1, the Commission presented more than six times the area of land provided for in Article No. 1. We mention that the total cost of the land purchased exceeded the amount allowed in Article No. 2, which was for a tract of the width as at present [illegible] plus [illegible], or [illegible].

It is obvious that the Commission, as at present built, requires only a comparatively small fraction of the funds that have been provided. Mr. Francis, in discussing what this matter on pages 4-13 and 4-22 of his report, states:

"It will be noted ... that in the relatively site of the [illegible] more land was required than the immediate needs of the Shipyard. Although Navy Shipyard [illegible] [illegible] in the Hunters-Electric Power Commission that these lands were primarily taken; it was considered advisable to do so in order to provide sufficient right-of-way for the [illegible] with the present [illegible]."

Mr. Kon [illegible] of the Commission [illegible] the greater [illegible] is not [illegible] Mr. Kon, [illegible] [illegible] before us that:

"... under the original estimate we contemplated providing a great deal more right-of-way than was necessary for the 150,000 h.p. development of 300,000 h.p."

From the foregoing we can come to one of the following conclusions:

(1) That the Engineers of the Commission when preparing Estimate No. 1 under-estimated the total amount of land required, or,

(2) That the engineers included in Estimate No. 1, only sufficient land for the development then under way and later purchased land required for development in the future, not yet commenced, and not provided for in the estimates.

In our analysis previously set forth, we have allowed the sum of $400,000 as a justifiable excess cost in respect of the six-unit plant. We believe that this is a very liberal amount as it would appear that the acreage could be considerably reduced and having regard to the fact that the price paid per acre was somewhat less than the amount estimated justifiable cost, in respect of right-of-way could be safely set at some figure considerably under $1,000,000. We have shown that the total amount actually spent was $1,400,000 and that the amount estimated was $600,000. There remains, therefore, still the sum of $400,000 to be accounted for. This, as Mr. Francis points out, represents acreage in excess of requirements, but at the same time it represents what may be terms a recoverable asset. Therefore, in our analysis, the amount of $400,000 is allowed as a justifiable excess expenditure.

Section 45

DISTRIBUTION OF COSTS

All figures deduced in the preceding pages of this report have been arrived at on the assumption that a contractor should have been employed to do the work and on this account the figures given include a reasonable profit plus all other charges which the Commission would have incurred had this plan of doing the work been adopted. On page 272 of this report we submitted a balance sheet which has formed the basis of our analysis up to this point. We now submit hereunder a summary of our analysis divided into two classes which are referred to earlier in this report as (a) uncontrollable items and (b) controllable items. This classification of the excess expenditure of $38,000,000 is as follows:

(a) Uncontrollable Items:		
Quantities, etc.	(approx.)	$7,200,000
Abnormal conditions	"	16,000,000
Underestimated	"	6,000,000
(b) Controllable Items:		
Over-expenditure	"	9,000,000
		$38,000,000

Summarizing further, we have the following:

(a) Total of Estimate for six-unit plant in use by Commission late in 1919, approximately	$26,500,000
(b) Total cost for six-unit plant as constructed	64,500,000
(c) Total additional cost, approximately	38,000,000
(d) Estimates late in 1919 when corrected for quantities, as built, and for shovel capacities and so forth for six-unit plant, should have been about	39,000,000

(e) Justifiable excess cost due to war-time conditions and all other reasonable factors $16,000,000

(f) Justifiable total cost of the six-unit plant as built including a reasonable profit had a contractor been employed to do the work 55,000,000

(g) Justifiable net cost of work would be something less than, say, ... 50,000,000

Section 46

OTHER ESTIMATES

General

In our discussion regarding the reasons for increases in estimates, we have confined our remarks entirely to those estimates which were prepared by the engineers of the Commission. It will be remembered that in a previous section of this report we have stated that two other important estimates were prepared during the year 1920, the one by Messrs. Hugh L. Cooper & Company, and the other by Messrs. Francis Lee Stuart and H. S. Kerbaugh. It will also be remembered that the estimate prepared by Messrs. Hugh L. Cooper & Company in 1920 agreed fairly closely with the actual costs of the work as completed, but that the estimate prepared by Messrs. Stuart and Kerbaugh in 1920 represented a figure considerably under the actual cost. In December, 1921, Messrs. Stuart and Kerbaugh were again engaged by the Commission to report upon the reasons why their estimate of cost had been so materially overrun.

Therefore, in order to complete our discussion of the general subject of increases in estimates, the following paragraphs will be devoted to a general discussion of the two estimates mentioned above.

Stuart and Kerbaugh Estimate September, 1920, and December 1921.

From our previous analysis in that part of this report dealing with the general subject of estimates and appropriations we have shown that the estimate prepared by Messrs. Stuart and Kerbaugh and presented to the Commission in September 1920, after allowing for the corrections made by Mr. Gaby, amounted to the sum of approximately $50,000,000 to complete a five-unit plant by the end of 1921. Now the comparisons given in previous sections have all dealt with a six-unit installation. It would seem reasonable therefore to add the sum of about $3,000,000 to the figure just above quoted in order to bring the Stuart and Kerbaugh estimate to a basis comparable with our present analysis. In this way we find that the estimate then made would amount to approximately $53,000,000. In passing, it will be noted that this figure is not dissimilar to the one which we have arrived at, namely $55,000,000, as representing what may be termed total justifiable cost.

As pointed out, the estimate prepared by Messrs. Stuart and Kerbaugh was considerably overrun, which fact resulted in the submission of what may be termed a justificatory estimate by these two gentlemen under date of December 13th, 1921, in which reasons are given for the excess costs.

Before discussing these reasons, it is pointed out that the agreement between the figures of $55,000,000 which we have arrived at and the figures of $53,000,000 on the basis of the 1920 estimate is supported by a relatively similar agreement of unit prices used in our estimate and those employed by Messrs. Stuart and Kerbaugh.

Tobacco and Distilling Activity Increases, 1920.
Net Income: 1920.

From our previous analysis in that part of this report dealing with the general activity of industries and corporations in more detail than the estimate prepared by Messrs. Stuart and Eastman and presented to the Commission in September 1920, after allowing for the corporations made by Mr. Eddy, amounted to the sum of approximately $20,000,000 to complete a five-year plan by the end of 1921. Even the conservative rates in previous settlements have all built with a minimum initiation. It would seem reasonable therefore to add the sum of about $2,000,000 to the figure just above stated in order to bring the Stuart and Eastman estimate up to a basis comparable with our present estimate. In this way we find that the net income that would accrue is approximately $20,000,000. In addition, it will be noted that this figure is not dissimilar to the conclusion we have arrived at, namely $22,000,000, as representing what may be termed total profitable net.

As pointed out, the estimate prepared by Messrs. Stuart and Eastman was distinctly serious, which does result in the estimate of what may be termed a justificatory estimate by those the questions under date of December 13th, 1920, in which reasons are given for the excess costs.

Before discussing these reasons, it is pointed out that the difference between the figure of $20,000,000 which we have arrived at and the figure of $20,000,000 on the basis of the 1919 estimate is explained by a relatively similar increase of such prices used in our estimate and those employed by Messrs. Stuart and Eastman.

In addition to an agreement of total costs and unit costs, we find that in the justificatory estimate of December, 1921, these two gentlemen attributed the extra cost to practically the same causes as those dealt with in previous sections of this report. For purposes of direct reference, therefore, we repeat hereunder a paragraph of this report:

"Costs.

Under this head we may state briefly at the outset that the major portion of the overrun on the September, 1920, estimate may be ascribed, directly or indirectly, to the unexpected falling down of the steam shovels and canal lining plants. The excess cost directly chargeable against these factors is of minor significance as compared with the indirect costs for which they were responsible, arising out of such conditions as (a) obstruction to the operation of other plant; (b) irregular and congested operation of railway and dumping services; (c) additional burden on power, water, air, drilling, blasting, superintendence, engineering and other auxiliary services and overheads; and (d) the necessity of employing a working force at least 20% larger than would otherwise have been necessary.

As to specific and ascertainable items of cost entering into the excess over the September, 1920, estimate, we find that they divide themselves into two general classes; (a) items of excess cost arising out of conditions which were justifiable, unforeseen and unexpected; and (b) items of excess cost arising out of conditions which were foreseen and appreciated from the beginning, but which were not seen in their true perspective as related to a 12 months' working schedule, which, to the best of our knowledge, was quite unprecedented.

Under the head of wholly unforeseen or unknown items we may specify the following:

(1)	Abnormal accidental contingencies ..	$1,000,000
(2)	Change in character of the rock	2,500,000
(3)	Cement and sand	350,000
(4)	Labor turnover	613,000
(5)	Extra Plant	1,381,487
(6)	Miscellaneous overheads	1,559,347
	T o t a l .	$7,403,834."

It appears clearly that Messrs. Stuart and Kerbaugh in September, 1920, submitted a report which was based largely on an orderly and systematic completion of this work, and on unit costs which Mr. Kerbaugh, as a contractor, states were such that he would be willing to take these prices as a basis for a contract. The estimate was further based on the assumption that extra equipment, necessary to maintain the working schedule required to complete a portion of the work by the end of 1921, would be immediately available, thus giving what may be termed a greatly increased working capacity for a period of fourteen or fifteen months. We believe that had the assumptions made by Messrs. Stuart and Kerbaugh been possible of accomplishment, their estimate would have been substantially realized, but the estimate then made failed to recognize two essential factors: first, that the Commission had unduly delayed the ordering of the amount of equipment necessary to complete the work in the time required, and that delivery of the desired extra plant could not be obtained in a reasonable period or of the type required; second, the estimate failed to realize that the work was not being done through the agency of a contractor but was being conducted as a Government job.

The resulting conditions proved most definitely our conclusions in this respect. The Commission, due to its delay in realizing or at least in correcting the conditions that obtained on the work since early in its commencement, were unable under the circumstances to obtain and put in operation the additional amount of equipment required until well on in 1921. This resulted in the chaotic condition to which we have previously referred in detail, and to which condition Messrs. Stuart and Kerbaugh definitely referred in that section of

their report just previously set forth.

It may be argued by some that with the information in hand at the time Estimate No. 2 was made that the engineers of the Commission were justified in using the capacity for shovel output that they did. Even so, it is to be remembered that the large electric units commenced operations early in 1918, and that from the start they never gave anything like the capacities which had been estimated for them, and this during the period of least inefficiency, and at a time when the shovels were working under the best conditions obtaining on the work. In this connection Mr. Gaby advances the excuse that they expected cost to greatly decrease after the Armistice in November, 1918. Obviously a reduction in labour and material costs, while having some effect on expenditure, could not have affected materially the output capacity of these shovels which after all was the main factor controlling and governing the speed and cost of this work.

With a sufficient amount of equipment on the work during the years 1918, 1919 and 1920 much more work would have been done during these periods, and during the years 1918 and 1919 when lower wage rates obtained and less inefficiency was apparent the cost of the work on the whole would have been materially reduced.

It may be said, therefore, that while the Stuart and Kerbaugh estimate of September, 1920, was substantially in error as compared with actual cost, the figures given in it fairly represent what may be termed a justifiable cost of this work.

Estimate prepared by Hugh L. Cooper, 1920.

The report of Hugh L. Cooper appears to have been prepared from an entirely different viewpoint from that prepared by Messrs. Stuart and Kerbaugh. First of all, we find that this estimate contemplates the completion of the work ready for the installation of the first units in the power house by the end of 1922 or the beginning of 1923. Looking for the reason of this extension of the working period, we find that the estimate apparently contemplates that the amount of equipment then on the work is not to be increased. On this basis, the period of time allowed by Mr. Cooper does not appear to be unreasonable in the light of ensuing results.

Again we find that the Cooper report and estimate is very conservative in its assumptions in reference to unit costs and output capacity of excavating equipment, the one being closely related to the other. Apparently Mr. Cooper found that the expectations of the engineers of the Commission were not being realized in this respect, and having regard to the work then to be completed put his unit cost on the most conservative basis. Furthermore, Mr. Cooper appears to have been thoroughly cognizant of the fundamental difference existing between construction work conducted on what may be termed a government basis, to that conducted on a contract basis. For his remarks in reference to labour conditions are very significant in this respect. In his report he says:

"With respect to the foregoing our observation of the labor performance on this entire job has convinced us that, broadly speaking, this labor has been very inefficient. This inefficiency in our judgment has not been due to any lack of zeal or intelligence on the part of those immediately responsible

for the handling of the labour, and we believe that the Construction Superintendent, Mr. George Angell, has achieved the best results that could possibly have been obtained as far as labour is concerned under the very trying conditions through which Mr. Angell and his subordinates have passed.

"All over the world it has always been observed that labour working for any government is always abnormally inefficient. The degree in which such labour fails to perform a reasonable day's work varies. The outstanding universal explanation of this difficulty of labour is found in the fact that a rich government is paying for their time."

The remarks made in reference to this matter are very similar to our own views previously expressed in this report and Mr. Cooper apparently had clearly conceived the idea that the manner in which the work was being conducted by the Commission was productive of costs in excess of those ordinarily encountered. That he believed this to be true is shown by recommendations made by him that a bonus system be introduced based upon man-hour output so that a stimulus might be provided for more economic work. We do not believe, however, that such a system would have had practical application at the time the recommendation was made, but Mr. Cooper's ideas in this respect only go to show that he believed economies could be affected which were not then being realized.

Making allowances, therefore, for all of these conditions it is not unnatural that Mr. Cooper should have arrived at a figure so much in excess of what may be termed justifiable cost, and while statements made in the report are of a somewhat conflicting character, and while some of the assumptions made vary considerably from results actually obtained, it cannot but be admitted that Mr. Cooper in making his report had in mind, perhaps

more clearly than anyone else at the time, the true perspective in reference to this undertaking.

Section 47

CONCLUSION

In our analysis of this matter, we have stated that the figure of $55,000,000, given as the maximum justifiable cost for the six-unit plant as built, provides for the work having been executed by a contractor on some modified form of the "cost plus" contract basis and our figure includes a reasonable profit for the contractor. In addition to the contractor's profit and overhead charges our estimate also includes a sufficient amount to take care of the Commission's overhead costs in supervising and financing this work. Consequently, it will be understood that our figure of $55,000,000 represents the total ultimate cost of the work as viewed from the owner's standpoint, every reasonable and possible allowance having been made for the unusual conditions under which the work was carried out.

Since our figure of $55,000,000 includes contractor's profit which we have figured at 10% above net cost, it follows that the net cost of this work should have been $50,000,000. If the basis on which the Commission proposed to do this work was a sound one, it should have effected further savings in respect of overhead costs, for economies should have resulted from combining the direction of engineering and construction in one organization. It will be seen, then, that had the Commission constructed this work at net cost as it stated it could, the total expenditure for the six-unit plant would have been something less than $50,000,000.

were clearly then beyond also of the city, and that productivity is increased in this manufacture.

Section II

Conclusion

In our analysis of this method, we have shown that the figure of $24,000,000, plus or the average monthly wage as well, yielding for the year during from manufacture by a monitoring in was modified from or the that plant manufacture basis and the figure includes a reasonable profit for the manufacture. In addition to the experimenter's profit and overhead during our estimate also includes a sufficiency amount in case of the financial [illegible] in operating and financing this year. Consequently, it will be emphasized that the figure of $24,000,000 represents the total expenditure of the work as planned from the project's standpoint, after reasonable and practice allowance having been made the general conditions under which the work was carried out.

Then the figure of $24,000,000 includes contractor's profit which we have figured at 20% above cost, it follows that the cost of this work should have been $20,000,000. If the result is which the complaint proposed to do this work was a sound one, it should have effected further savings in regard of overhead costs. For economies should have resulted from consulting the director of engineering and construction in the preliminary. It will be seen, then, that the Commission has accounted this work at not more or it proved is worth, the total expenditure for the elevated plant would have been somewhere less than $20,000,000.

In conclusion, it may be stated, therefore, that everything points to the fact that, on the bases of representations made to the Government, the Commission has utterly failed to make good its statements. The work for a six-unit plant, which should have cost less than $50,000,000, actually cost $64,300,000, so the work has cost about $15,000,000 more than it should.

PART X - CONSTRUCTION METHODS AND MANAGEMENT

Section 48

G E N E R A L

In Part IV, entitled "Construction Procedure", we have dealt generally with the physical operations relating to the actual conduct of the work, but no particular references were made therein to the details of supervision and management. In Section 15 of that part we have indicated the manner in which the work was conducted and in it and subsequent sections have shown that the great bulk of the work was carried out directly by the Commission on a force account basis.

The decision of the Commission to conduct construction operations itself rendered necessary the establishment of an organization to take care of the actual control and management of the work. The nature of the organization so formed is dealt with in detail in our Consulting Engineer's report entitled "Chapter F - Organization", and it is largely from that document that the following statements have been procured.

The question referred to this Commission in the Letters Patent in reference to the general subject of construction methods, supervision and management, reads as follows:

> "The methods of construction, supervision and management which have been employed in the Queenston-Chippawa Power Development, and whether they can justifiably be continued for the economical completion of the work."

Part I - Constitution Building for Plantations

Section 24

[illegible]

In Part IV, entitled "Constitution Development", we have dealt generally with the physical operations relating to the actual commencement of the work, but no particular emphasis was then shown in the details of organization and management. In Section 12 of this part we have indicated the manner in which the work was commenced and in it and subsequent sections have shown that the great bulk of the work was carried out directly by the Commission on a force account basis.

The success of the commission in making reasonable expenditure time itself requires necessary the establishment of an organization to take care of the actual control and management of the work. The nature of the organization so formed is dealt with in detail in our (Building Department's report entitled "Chapter 7 - Organization", and it is largely from that document that the following statements have been prepared.

The practice followed on this Commission in the letters patent is referred to the general method of construction contracts, supervision and management, which is indicated:

> "The methods of construction, supervision and management which have been employed in the Commission-Chippewa River Development, and whether they can justifiably be continued for the successful completion of the work."

Section 49

CONSTRUCTION METHODS

In discussing this particular subject our remarks will be confined entirely to references regarding the nature of the equipment selected to do the work and the general plan adopted for carrying it out. In this connection only the principal items of plant will be referred to, especially those having to do with the excavating and concreting work done in the canal.

Excavating Units

We have previously set forth in detail the nature of the equipment purchased and the actual service which it rendered while in operation. It would appear that, on account of the magnitude of the work, requiring a long period of time for its construction, the purchase of large excavating units was based upon sound judgment and good construction practice. It is believed that the decision so made was rendered especially advisable by the fact that the test borings carried out when the project was first under consideration showed that the earth overburden was largely saturated with water and that quicksand was likely to be encountered in the excavation.

By the use of large excavating units having high lifts it was possible in most instances for the working base of the shovel to be on a solid foundation, namely, the rock surface. The large shovels were not only excavating units, but also elevators lifting the excavated material to work trains on a track system, which operated at high levels. The desire of the Commission's engineers to operate these shovels electrically was, we believe, also well founded. It must be remembered that the Commission

Section 32

CONCLUSIONS AND SUMMARY

In discussing this particular subject our remarks will be confined entirely to reference regarding the survey of the equipment selected to do the work and the general plan adopted for carrying it out. In this connection only the principal items of plant will be referred to, especially those having to do with the assembling and accessorizing work done in the vessel.

Conversion Units

We have previously set forth in detail the nature of the equipment purchased and the actual service which it rendered while in operation. It would appear that, on account of the magnitude of the work, requiring a long period of time for its accomplishment, the purchase of large accessorizing units was based upon sound judgment and good manufacturing practice. It is believed that the decision to make this purchase especially advisable by the fact that the last having arrived was when the project was first under consideration meaned that the entire overhauling was largely carried with money and that equipment was likely to be accumulated in the meantime.

By the use of large accessorizing units having high lifts it was possible to work inclosure the working deck of the vessel so as to be well furnished, namely, the work shelter. The large diesels were not only accessorizing units, but also alongside lifting the accumulated material to work benches on a track system, which operated at high levels. The design of the manufacturer's engineers to operate these diesels electrically was, we believe, also well founded. It must be remembered that the installation

was in an ideal situation to obtain electric power and the results shown by analysis of comparative performances between electrically driven and steam plant, show that electrically driven shovels operated at a less cost than those driven by steam.

Transportation Facilities

The selection of equipment for transporting the spoil from the site of operations to the disposal areas was to a large extent governed by the type of excavating equipment used. With excavating units having a large output capacity, it was of primary importance that the transportation facilities should be so constructed and of such a type that uninterrupted service could be rendered to the excavating machinery. It would appear that the engineers of the Commission were well advised in adopting a standard gauge railway system, well constructed and ballasted, served with motive equipment and large steel dump cars of the latest type.

The selection of large excavating units had an important bearing on the transportation system in that the gradients were reduced to a minimum, for the track system was kept well above, and clear of, the actual working levels. Much of the motive power was supplied by electrically driven locomotives and it would appear from the records that, like the electrically driven shovels, these were operated at less expense than the steam driven equipment.

Concreting Plant

As already stated the original concreting plants supplied to the Commission failed, and it became necessary for the engineers of the Commission

to make designs for new plants which were constructed on the site. On first consideration it would appear that the decision of the Commission's engineers to use elaborate and expensive equipment in connection with the lining of the canal is open to question. It is to be remembered, however, that the lining of the canal cannot be considered as an element having any structural value such as a retaining wall, and it must, therefore, be regarded merely as a means of providing the rock section of the canal with a surface to reduce friction to a minimum.

In view of this fact and the water saturated condition of the excavation, it is obvious that had this portion of the work been constructed over two working seasons, thus allowing portions of the lining to stand unprotected during the winter, there would have been grave danger of the concrete work failing on account of frost acting on the accumulated water behind the wall. The Commission, therefore, properly decided that this portion of the work must all be carried out during the element months immediately following the completion of the rock excavation so that the water could be immediately admitted to the canal, thus counteracting the danger from frost.

It is quite apparent that, when the canal is filled with water, the temperature of the ground water behind the wall can never fall below freezing point, and all danger of ice pressure against it is thus eliminated. Such a danger would exist were it ever found necessary to unwater the canal during the winter season, but the possibility of this condition arising is very remote.

Having all of these factors in mind, therefore, it was necessary

for the Commission to adopt such means as would enable it to complete the lining work in the shortest possible time, and to produce a surface having the smoothest texture possible. Both of these objectives were realized. The concrete lining to the canal was commenced in November, 1920, and the bulk of it was completed by the middle of December, 1921, eighteen days after the excavation was completed. Water was admitted to the canal on December 24th. As will be noted from photographs given in previous sections of this report, the walls of the canal present a dense, smooth and even texture and the alignment is excellent.

Disposal Areas

The main disposal area as originally decided upon by the engineers of the Commission is that commonly known as St. David's. They also originally had in mind the filling in of Bowman's Gully which decision fulfilled the dual purpose of providing for the disposal of about 1,700,000 cubic yards of material and of providing a means of crossing this depression with the canal.

The selection of the Bowman's Gully disposal area was a matter of necessity, but the selection of the main disposal area was a matter of judgment and the site decided upon appears to have been the most logical one possible. By referring to a map previously given on page 95 of this report it will be noted that this disposal area was located on the edge of the Niagara escarpment and the land comprising it consisted of lands not suitable for cultivation. By reason of the fact that it was located at the edge of the escarpment, it was possible by a simple system of trestling

to obtain a good depth for the disposal of the spoil and a simple approach to the area for the transportation system. It was probably the best and most convenient location that could be obtained in the district adjoining the Development. Over 6,000,000 yards of material were deposited at this place.

The next disposal area of importance is that known as Lundy disposal area. The selection of this site may be regarded as an after-consideration, largely necessitated by the rush schedule which was inaugurated in 1921. Due to the tremendous amount of work being done on the canal during that period, it was found impossible to operate a sufficient number of trains to the main disposal area to serve the shovels. It was, therefore, necessary to distribute the transportation of the excavated materials to more than one place. The choice of the Lundy disposal area was made with this object in view, namely, its convenient location to the work.

On the other hand, under the conditions existing it is doubtful if any other area could be chosen which would give facilities equal to those obtaining at the main disposal area. Generally speaking the Lundy disposal area was located on ground approximately level with the canal itself and did not have the advantage afforded by the escarpment. The operation of work trains to it necessitated the construction of a considerable amount of approach trestle work which increased the cost of operation.

The other disposal areas, chiefly those in connection with dredging operations, were chosen at locations convenient to the work, and appear to have served their purpose well.

is known a great depth for the disposal of the spoil and is single-opened in the area due the transportation system. It was possible that that not most accessible location that would be chosen in the Electric electrical the development. Here a,243,243 people participated were questioned with phone.

The work planned area of importance is also known as Lundy disposal area. The selection of this site may be regarded as an affirmative availability, largely necessitated by the rock stability which was incorporated in 1821. Due to the transmission method at rock depth-down in the past during that period, it was final impossible to operate a artificial number of trains to the rock disposal site in Lundy due to stability. It was, therefore, necessary to distribute the transport ration of the excavated materials to more than one place. The choice of the Lundy disposal area was made with this object in view, namely, its convenient location to the work.

In the other hand, under the monitoring activity is desired. If any other area could be chosen which would give facilities equal to those obtaining at the main disposal area. Generally operating the Lundy disposal area was located on ground approximately level with the canal itself and did not have the obstacles offered by the mountains. The question of both trains or it necessitated the substitution of a mechanical method of operation totally such that increased the cost of operation.

The other disposal areas, namely those in connection with brick-lay quarries, were closer of locations convenient to the city, and further it have served their purpose well.

Miscellaneous

In addition to the main items mentioned, the work as planned and carried out included many other elements of an important character. A very complete repair centre consisting of machine shop, locomotive house, etc., was constructed and equipped with the best type of machinery obtainable. While the cost of these buildings was a very large item, their necessity is apparent on a work of this magnitude. As a matter of fact with the conditions prevailing during the war and post-war period, it was necessary to carry out in these shops major repairs which under ordinary circumstances would have been done elsewhere or the parts required supplied by the manufacturers.

General Procedure

It may be concluded, therefore, that the general type and nature of the equipment selected by the Commission was suitable for work of this nature and magnitude. Generally speaking also the planning of the transportation system and the location of the disposal areas appears to have been good. As to the actual conduct of the work, the most graphic conception of the procedure followed in this respect may be obtained by referring to pages H-131 to H-140 of our Consulting Engineer's report entitled "Construction Plant, Earth and Rock Excavation, Canal". These pages consist of progress charts showing month by month the excavation completed and the location of the various shovels.

The engineers of the Commission have stated at various times that they always regarded the excavation in the canal as the governing feature of the whole Development in so far as time of completion was concerned. Their

Discussion

In addition to the data items mentioned, the data we planned and carried out included many other elements of an impartial evaluation. A very complete report covering of physical size, inventory items, etc., was constructed and equipped with the last word or technology obtainable. While the most of these activities was a very large item, their necessity is apparent so it was a'ddy accomplished. As a matter of fact with the difficult installing during the war and post-war period, it was necessary to carry out in these large major projects which under ordinary circumstances would have been done elsewhere or the parts required supplied by the manufacturers.

Legal Problems

It may be mentioned, incidentally, that the general type and nature of the systems selected by the Commission was entirely our own of this nature and magnitude. Generally speaking also the planning of the transportation system and its function at the disposal areas appears to have been good. As to the actual manner of the work, the most valuable analysis of the problems followed in this report may be obtained by referring to pages 2-121 to 2-242 of the Committee Engineer's report entitled "Rehabilitation Plan, Paris and Inner Zone Districts, Part". This gives a series of photographs showing work by much the interesting engineers and the problems of the various sectors.

The engineers of the Commission have raised of various times that they always regarded the assumption in the need as the governing factor of the whole development in so far as this or employing the successful. Their

view in this respect is supported by the advice given them by other consulting engineers employed to make reports. Reference to a profile of the Development will indicate that this was the case. While the completion of the canal was undoubtedly the governing factor, as a whole, there was a certain section of the canal, that comprising miles 3, 4 and 5, which in turn controlled the completion of the canal itself. These three sections had an average depth of approximately 110 feet, while the balance of the canal had an average depth of only about 60 feet. One would naturally assume, therefore, that the point of first attack would be the deepest section of the canal involving the greatest yardage. Especially would this appear to be the proper procedure when it is considered that the greatest depth of rock excavation existed also within this three mile limit.

Referring to page H-131 of our Consulting Engineer's report, we find that initial operations were commenced at Bowman's Gully, it being stated by the engineers of the Commission that by so doing natural drainage could be obtained. Continuing reference to the charts in Mr. Francis' report we find that from the commencement of operations in 1917 up to the month of April, 1919, nearly two years later, the deep section of the canal above referred to had not been attacked.

Apparently the main reason for the delay in commencing this part of the work was the difficulty encountered by the Commission in obtaining authority from the Grand Trunk Railway Company to construct a crossing under its tracks. The records of the Commission show that the necessary permission was obtained only after negotiations and correspondence covering a period roughly from June, 1916, to November, 1917. It appears that the officials

that in this process is supported by the advice given them by some scientific engineers employed in some reports. Inclusion in a portion of the development will indicate that this was the case. While the complexities of the model are undoubtedly the strongest factor, as a whole, there was a certain portion of the model, that complicated cells 2, 3 and 5, which in turn complicated the complexities of the model itself. These cells actually had an average depth of approximately 150 feet, while the bottom of the model had an average depth of only about 40 feet. One would certainly assume, therefore, that the prime of first effect would be the damped portion of the model involving the deepest portion. Theoretically really this appears to be the primary interpretation when it is considered that the greatest depth of the model actually related also within this cell.

Referring to page 5-113 of the Operating Department's report, we find that initial operations were conducted at Bikini's Shoal, it being stated by the engineers at the Operations that by 27 minutes previous initiation until 30 minutes. Continuing reference to the model, in Dr. Bowlin's report we find that upon the commencement of operations in 1947 up to the month of April, 1948, nearly two years later, the deep portion of the model above referred to had not been attained.

Apparently the main reason for the delay in commencing this part of the work was the difficulty encountered by the Operations in obtaining sufficiently close the blood cross bulkhead damped to construct a crossing water its tunnel. The results of the Operations show that the necessary production was obtained only after re-positioning the partitioning separating a portion nearly from free, 1948, in December, 1947. It appears that the difficulty

of the Railway Company put many obstacles in the way of the Commission in connection with this matter.

As stated above it was approximately eighteen months before the Commission finally obtained authority to construct a crossing under the Grand Trunk tracks. Inasmuch as construction work was not commenced until May of 1917, and then only to a very small extent, the delay is not as great as it would at first appear. At the same time, it was during 1917 that the Commission should have been constructing their service railway and getting ready for a big year in 1918.

Having regard to this fact, we believe that much more pressure could have been brought to bear on the Grand Trunk Railway Company to further the interests of the Commission, and, while the Railway Board at Ottawa appear to have considered it outside of their jurisdiction to press the matter, we believe that had the Commission enlisted the co-operation of the Provincial Government in making representations at Ottawa to a greater extent than it did, the matter would have been disposed of much more quickly, but it is not surprising, having regard to other actions of the Commission, to learn that such co-operation was not taken advantage of to any great extent and a great deal of the negotiations were carried on in a more or less desultory manner by some of the Commission's engineers. At all events even though authority to construct the crossing was not obtained until November, 1917, had the work then been rushed and a large working force then employed, the resulting delay would not have had such great significance as it did.

Generally speaking, we have given unqualified approval of the

type and nature of equipment selected by the Commission to do this work and the general planning that was adopted in reference to transportation system, disposal areas and so forth. The best laid plans, however, can be almost entirely disrupted by a wrong assumption in reference to some fundamental and basic matter. This appears to have been very definitely the case in construction procedure on the Queenston-Chippawa Power Development. We will not repeat at this place our discussions and analyses of the estimated capacity of the equipment as compared with the actual capacity as this matter has been dealt with most fully in a preceding part of this report. It was to a large extent an error of judgment in this matter that led to the chaotic conditions existing on the work during the year 1921 and the greatly increased cost.

Among other reasons given by the Commission for not pressing the progress of this work during the earlier years, was the fact that great difficulty was experienced in getting a sufficiency of labour to carry on the work effectively. That it was impossible to increase the working force during the year 1918 does not, however, appear to be the case, for, as stated elsewhere in this report when dealing with the general history of the project, we find that, according to statements made by our Consulting Engineer, at the suggestion of the Power Controller of the United States, conferences were held in May, 1918, between the officers of the Commission and the Power Controller of the United States to consider the possibility of completing the Development within a year from that date.

IN July of 1918 improved conditions at the Front led to the

type and nature of equipment selected by the Commission to do this work but the general planning that was adopted is reminiscent of transportation systems, diagonal roads and so forth. The last half point, however, was be almost entirely dependent by a strong campaign to convince the people of Ontario and Canada generally. This campaign is here been very effectively the same in construction promotion on the Commission-Ontario Power Development. We will not repeat in this place the discussion and analysis of the extensive capacity of the equipment as compared with the normal capacity as this matter has been dealt with more fully in a preceding part of this report. It was to a large extent an error of judgment in this matter that led to the chaotic conditions existing on the work before the year 1908 and the greatly increased cost.

Among other reasons given by the Commission for not proceeding the progress of this work during the earlier years, was the fact that great difficulty was experienced in getting a sufficiency of labour to carry on the work effectively. That it was impossible to increase the working force during the year 1910 does not, however, appear to be the case. Certain stated statistics in this report when dealing with the general history of the project, on that date, according to statements made by our Construction Engineer, in the supervision of the Power Commission of the United States, conferences was held in May, 1910, between the officers of the Commission and the Power Commission of the United States to consider the possibility of completing the development within a year from that date.

In May of 1910 between conditions as the Power had to the

abandonment of the suggested attempt to rush the work to completion at any cost. Mr. Francis then says that during the year 1918 the work progressed comparatively slowly, largely on account of the shortage of labour. We do not believe that the work would have been finished by May, 1919, but a reasonable increase in the working schedule at that time should have been put into effect as a matter of ordinary good business practice, for the amount of equipment in use and the working force employed was entirely too small.

There is another matter to be remembered in connection with this work, and that is that the work was largely done by machinery. A certain amount of labour was necessary, but nothing like the proportion that might be imagined. There is no doubt in our minds that had the number of excavating units been earlier increased, the relatively small increase in the labour necessary to serve them could have been obtained, and the work put on a basis commensurate with its nature and magnitude. Any experienced contractor knows that there is a certain psychological effect instilled into a body of men by forcing operations from the start. The attempt is usually made to introduce the element of speed into any organization when it commences operations for it is realized that it is very difficult to speed up a working force after it has been lagging.

As we have stated elsewhere, assuming that the engineers of the Commission were justified in the opinion which they had in 1917 in estimating the capacities of the shovels at double the amount which they later did actually

establishment of the supposed island, in which the work is conducted at any moment. The travels then went still further the year with an most precisely comparatively also, largely on account of the shortage of labour. It is not believe that the work would have itself by 1947, but a reasonable increase in the working personnel so that this should have been put into effect as a matter of necessary and immediate urgency, for the amount of equipment in use and the working force employed was entirely too small.

There is another matter to be remembered in connection with this work, namely that it is by the most its largely been a matter of a certain degree of luck and serendipity, and not by this the geographical that might be therefore. There is no doubt in my mind that the method of searching also been applied for the relatively small increase in the latter probability is more than could have been obtained, and by such an a basis experiments with the e-ray and neutrons. The experimental evidence here that there is a certain geophysical effect installed into a body of ness by during operations from the start. The effect is usually made to increase the amount of speed into any crystal when it commence operating but it is realized that it is very difficult to speed up a working rate after it has been laughed.

As to the final statement, concerning the methods of the classic case published in the quarter which they had to 1947 to substantiate modification of the models to locate the issues which they later did successfully

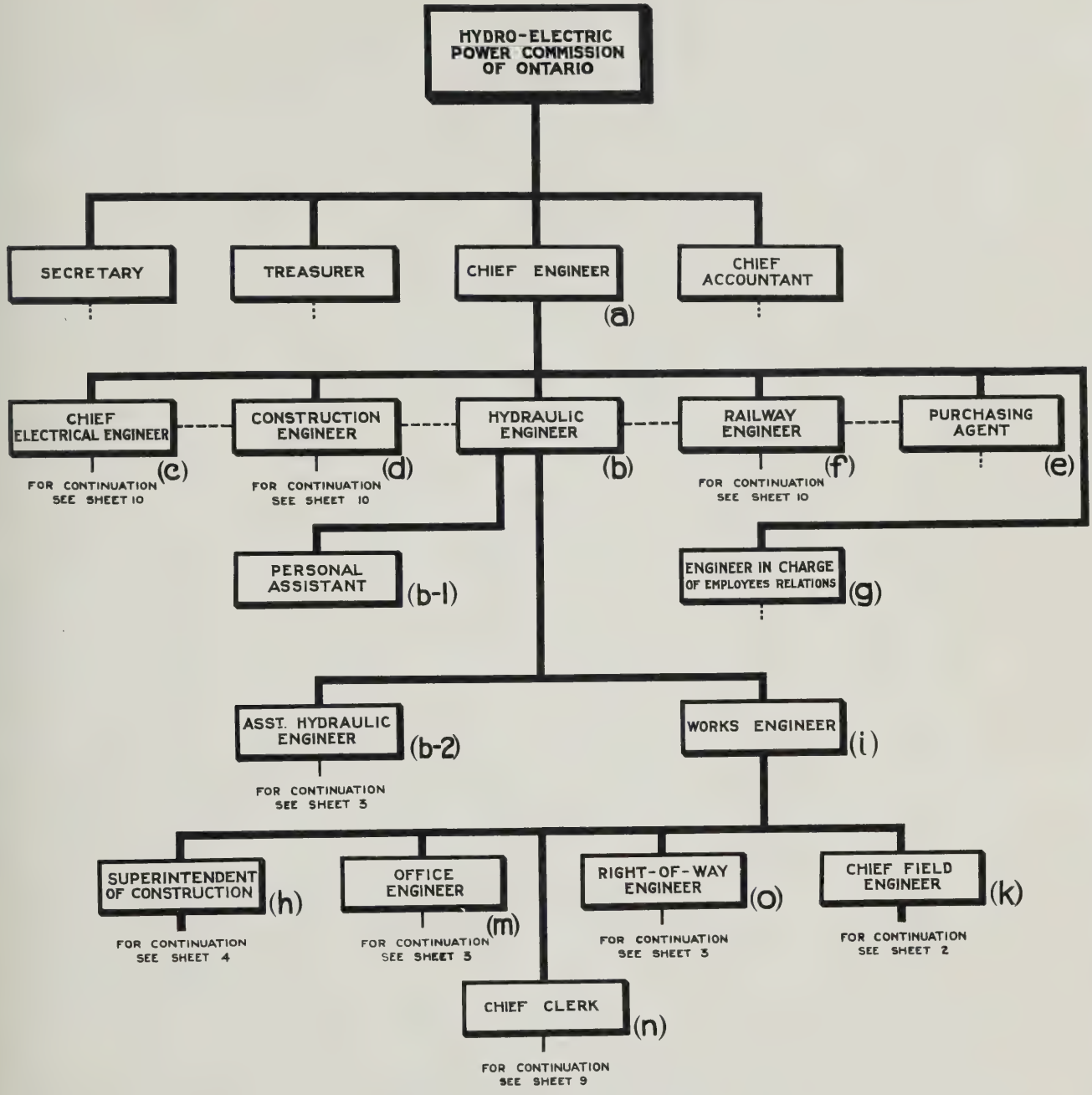
perform, they soon learned the nature and extent of their error, and, by the end of 1918 or certainly not later than the year 1919, corrective measures should have been put into effect, and the amount of equipment greatly increased, resulting in an orderly and systematic completion of the work as at the time estimated. It can only be concluded, therefore, that the construction procedure in this respect and the general management directing it failed to correct certain basic features until it was entirely too late.

Section 50

ORGANIZATION AND MANAGEMENT

Up to this point we have dealt chiefly with the matter of selection of equipment and its general employment on the work. We have previously shown that the Commission conducted the greater portion of the work on what may be termed a force account basis. Having made this decision the Commission was compelled to create an organization to direct operations.

In connection with this subject our Consulting Engineer has prepared a report entitled "Chapter F - Organization", which clearly sets forth the plan adopted by the Commission in creating an organization to direct the work. In the report referred to, Mr. Francis includes as pages F-3 to F-12, charts giving in graphic form the lines of responsibility in reference to the control and direction of the work. We include on page 354 a chart showing the general nature of the organization, and, if details are required, they may be obtained from the other charts referred to. The chart on page 354 shows the organization from the Hydro-Electric Power Commission down to the heads of the various departments connected with the Development. The



HYDRO-ELECTRIC INQUIRY COMMISSION

W. D. GREGORY-CHAIRMAN

QUEENSTON-CHIPPAWA POWER DEVELOPMENT

CHART SHOWING ORGANIZATION FOR QUEENSTON-CHIPPAWA POWER DEVELOPMENT

(SHEET 1 OF A SERIES OF 10 SHEETS)

Toronto, Sept. 4th. 1922 Made by [illegible] Checked by [illegible]

WALTER J. FRANCIS, C.E.,

CONSULTING ENGINEER

13

details of the organization in various departments are given fully on the subsequent charts in our Consulting Engineer's report with suitable cross references so that the relationship between all parts of the organization may be readily traced.

While the functions of the more important heads are fully described in Mr. Francis' report, we will in this report deal only with those who may be considered the principal directing heads.

The Commission

The Hydro-Electric Power Commission of Ontario assumed the full responsibility for the work, and in doing so issued instructions to four principal officers, namely, the Secretary, the Treasurer, the Chief Engineer and the Chief Accountant.

In view of the fact that this report deals primarily with the construction of the Development, we will not elaborate upon the functions of the Commission or upon its personnel or with its relationship to the Secretary, the Treasurer and the Chief Accountant.

The Chief Engineer

The position of Chief Engineer of the Commission has been occupied by Mr. F. A. Gaby since 1912, and his qualifications are given on page F-32 of our Consulting Engineer's report. The Chief Engineer, in addition to his other duties connected with the work of the Commission, had direct charge of the Development. Immediately under his direction came the following officers: the Chief Hydraulic Engineer, the Chief Electrical

details of the organization in various departments are given fully on the subsequent sheets in our Consulting Engineer's report with suitable cross references so that the relationship between all parts of the organization may be readily traced.

While the functions of the more important heads may fairly be described in our Consulting report, we will in this report deal only with those who may be considered the principal directing heads.

The Constitution

The Cyclo-Gyrotic Power Generation of Energy assumed the full responsibility for the work, and is doing so licensed instructions by their principal officers, namely, the Secretary, the Treasurer, the Chief Engineer and the Chief Accountant.

In view of the fact that this report deals primarily with the organization of the Development, we will not elaborate upon the functions of the Committee or upon its personnel or with its relationship to the Secretary, the Treasurer and the Chief Accountant.

The Chief Engineer

The position of Chief Engineer of the Constitution has been occupied by Dr. A. A. Duke since 1923, and his qualifications are given on page 5-DA of our Consulting Engineer's report. The Chief Engineer, in addition to his other duties connected with the work of the Constitution, has direct charge of the Development. Immediately under his direction come the following officers: the Chief Hydraulic Engineer, the Chief Electrical

Engineer, the Construction Engineer, the Railway Engineer, the Engineer in charge of Employees' Relations, and the Purchasing Agent.

For the construction of the Development, the Chief Engineer's primary function was to receive instructions from the Commission and to issue corresponding orders to his various departmental heads. He obtained reports from them, approved the plans developed by them and generally directed policy and procedure. A perusal of the details of the Chief Engineer's experience indicates that his technical training and practical experience up to 1907 is essentially that of an Electrical Engineer. He joined the staff of the Commission in 1907 as Assistant Chief Engineer, being appointed Chief Engineer in 1912, since which time he has occupied that position. Though the principal director of this Development, the experience which the Chief Engineer had gained in construction work must necessarily have been gained largely during the period that he has been with the Commission, and in this connection it is to be observed that no work of great magnitude had previously been undertaken by the Commission, and the work that had been done was largely done by contract.

WJF.
P-14

The Chief Hydraulic Engineer

The position of Chief Hydraulic Engineer has been held since its formation in 1909 by Mr. H. G. Acres. The qualifications of the Chief Hydraulic Engineer are given on page P-33 of our Consulting Engineer's report, and in observing them it will be noted that our remarks regarding the construction experience of the Chief Engineer apply also to Mr. Acres. The Chief Hydraulic Engineer reports directly to the Chief Engineer and has charge of the Hydraulic Department of the Commission at Toronto, as well

Engineer, the Construction Engineer, the Railway Engineer, the Engineer in charge of Employees' Welfare, and the Purchasing Agent.

Due to the construction of the Development, the Chief Engineer's primary function was to receive instructions from the Consulting and to have corresponding orders on his various departmental heads. He received reports from them, approved the plans developed by them and generally directed policy and procedure. A perusal of the details of the Chief Engineer's duties indicates that his technical training and practical experience qualified him to work satisfactorily that of an Industrial Engineer. He joined the staff of the Commission in 1947 as Maintenance Chief Engineer, being appointed Chief Engineer in 1951, whose duties he has occupied that position. Though the criticisms directed at his Development, his experience with the Chief Engineers has proved in retrospection was most unnecessarily harsh been guided largely during the period the 5 he has been with the Commission, and in this connection it is to be observed that no work of great magnitude has practically been undertaken by the Commission, and the work that had been done was largely done by contract.

The Chief Industrial Engineer

The position of Chief Industrial Engineer has been left vacant its duration is 1949 to 1951. The qualifications of the Chief Industrial Engineer are given on page 4-23 of the Commission Engineer's report, and in observing them it will be seen that our remarks regarding the recruitment experience of the Chief Engineer apply also to him, hence. The Chief Industrial Engineer reports directly to the Chief Engineer and has charge of the Industrial Department of the Commission at Toronto, as well

as that of the Queenston-Chippawa Power Development, with the exception of some specialized details.

The function of the Hydraulic Department is to prepare all reconnaissance and other surveys, with corresponding estimates, in accordance with standard practice, in connection with all power developments under consideration by the Commission. It is also the function of this department to prepare detail plans, specifications and estimates for such projects and to supervise construction. As engineers, the staff of the Hydraulic Department directs the actual construction operations of the Construction Department of the Commission. This function applies to all hydraulic works in connection with hydro-electric projects, including the substructures, the buildings, and the purchase and installation of hydraulic machinery and auxiliaries connected therewith.

In the case of the Development this general method of procedure was varied on account of the magnitude of the work and the conditions prevailing during the construction period. The Chief Hydraulic Engineer had complete charge of the general design and of the construction of the Development, with the exception of the bridges, which were designed by the Railway Department. A special construction force was organized under the immediate direction and control of the Chief Hydraulic Engineer and with the exception of minor contracts, the whole of the permanent construction complete and ready for the permanent structures and machinery was done by it. The electrical equipment of the power house, not under contract, was erected

by the Electrical Section of the Construction Department, the Chief Hydraulic Engineer being in immediate charge of the necessary co-ordination. The invoices for all materials purchased were received and examined by the Chief Hydraulic Engineer who, on satisfying himself as to the correctness, approved and passed the documents for payment. He likewise issued all certificates in connection with contracts.

The Chief Hydraulic Engineer received his instructions from the Chief Engineer and he directed the construction work through the Works Engineer whose whole time was devoted to the Development. WJF. F-14.

The Works Engineer

The Works Engineer was the principal official on the Development, devoting his entire time thereto. The position was occupied by Mr. Jas. B. Goodwin, whose qualifications are set forth on pages F-49 and F-50 of our Consulting Engineer's report. In observing the details set forth on the pages mentioned we find that from 1892 up until 1908 Mr. Goodwin had been largely employed in the capacity of professional engineer. During the period 1908 to 1914 it would appear that his practical experience had largely been that of construction superintendent in active charge of construction work for contracting companies and municipal corporations.

The Works Engineer was directly responsible to the Chief Hydraulic Engineer and directed both the engineering and the construction forces. The principal members of his staff consisted of the Superintendent of Construction, the Chief Field Engineer, the Office Engineer, the Right-of-Way Engineer and the Chief Clerk, all of whom had their properly organized staffs. WJF. F-18

Mr. Goodwin relinquished active work late in 1920 owing to ill health. It would appear that Mr. Goodwin's health had not been good for some time prior to this date as he found it necessary to take an extended vacation in the south at this time. It is to be regretted that this vacation did not have the desired results, for on April 21st, 1921, a staff notice was issued which stated in part as follows:

> "Since his return from California, Mr. Goodwin has served notice that on account of his unfortunate indisposition, he will be unable to maintain his previous relationship with the Niagara Construction work in the capacity of Works Engineer." File 119/2

The services of Mr. Goodwin were, however, retained in an advisory capacity and he was assigned direct supervision over certain routine branches of the work. Following this change the notice to staff instructed that:

> "All departments heretofore reporting to the Works Engineer will report to the Hydraulic Engineer.
>
> "All plans prepared in the Construction Office shall be approved by the Hydraulic Engineer prior to issue.
>
> "All departmental correspondence shall be signed by the Hydraulic Engineer."

Concurrently with this readjustment in the organization, Mr. Acres moved to Niagara Falls and personally directed the operations until the completion of the work.

At this time, namely, the end of 1920, about 70 per cent. of the earth excavation had been completed, and about 35 per cent. of the

Mr. Dennis Hollingshead entire year July in 2000 doing in
ill health. It would appear that Mr. Dennis's health has not been good
for some time prior to this date so he found it necessary to take an un-
limited vacation in the month of this time. It is to be regretted that this
vacation did not have the desired results, for on April 21st, 2001, a staff
notice was issued which stated in part as follows:

> "Since his return from California, Mr. Dennis has served notice
> that on account of his worthless health condition, he will be
> unable to continue his position satisfactorily with the Kingsmen
> Construction Co. in the capacity of Chief Engineer." 1319/2

The services of Mr. Dennis were, however, retained in an ad-
visory capacity and in the enclosed direct communication sent certain problem
because of the work [illegible] this change the notice to start immediately
that:

> "All departments involving reporting to the Chief Engineer
> will report to the Optimile Engineer.
>
> "All plans prepared in the Construction Office must be
> approved by the Optimile Engineer prior to issue.
>
> "All departmental correspondence shall be signed by the
> Optimile Engineer."

Concurrently with this modification in the organization, Mr.
Jones moved to Kingsmen Falls and personally directed the construction until
the completion of the work.

At this time, namely, the end of 2000, about 75 per cent, or
the work approximately had been completed, and about 40 per cent, or the

rock excavation. The total expenditure as of October 31st, 1920, is shown by the records to be approximately $25,000,000, out of a final cost for the whole work of $82,000,000. It may be generally stated, therefore, that at the time Mr. Goodwin relinquished active control of the work only about one-third of what the finished work will cost had been expended.

The Chief Field Engineer

The position of Chief Field Engineer has been held by Mr. A.C.D. Blanchard who had direct charge of all field engineering work, of all inspection work, and of the progress records, reporting directly to the Works Engineer. His principal assistants in carrying out the work were two Division Engineers, an Assistant Engineer, an Assistant Engineer in charge of the field laboratory, and, for a short period, a special assistant. In addition, the Chief Field Engineer gave instructions to the Photography Department regarding the making of photographic records from time to time. WJF. F-19

Superintendent of Construction

The position of Superintendent of Construction was held by Mr. Geo. H. Angell, the qualifications of whom are given on pages F-44 to F-48 of our Consulting Engineer's report. A perusal of the information contained on these pages seems to indicate that Mr. Angell was a man of very wide experience in construction work and had been in active charge of very important operations. That he was a man of wide experience and considerable ability in the handling of big work seems to be supported by an offer recently made him by a large contracting firm of Boston, Massachusetts,

[illegible] distribution. The first screening on 27 October [illegible], 1929, is among the reasons to be remembered [illegible], and it is fitted that the whole work of [illegible]. It may be generally assumed, therefore, that at the time [illegible] production units existed of the work made about [illegible] years ago when the studios were still [illegible] and [illegible].

The Chief Field Engineer

The position of Chief Field Engineer has been held by Mr. [illegible] Blackburn for the greater portion of all [illegible] recording work, of all importance work, and of the [illegible] studios, travelling throughout the [illegible] Empire. His principal assistants in carrying out the work were the Sixties Engineer, an Assistant Engineer, an assistant Engineer in charge of the field laboratory, and [illegible] sound [illegible], a [illegible] assistant. In addition, the Chief Field Engineer also [illegible] in the [illegible] experiment concerning the making of phonographic records from time to time.

Development of Equipment

The position of [illegible] of Development [illegible] Mr. E. Lapell, who [illegible] of our Recording Engineer's staff. [illegible] at the laboratory and [illegible] times place, when in Hollywood also Mr. Lapell was a man of very wide experience in manufacturing work and had been in active charge of very important [illegible]. That he was a man of wide experience and considerable ABILITY in the building of his work issue is be evidenced by an article recently made him by a [illegible] contributing film [illegible] Transcontinental,

wherein he was offered the position of superintending the entire construction of the Gilboa Dam for the Board of Water Supply of New York City.

In his position of Superintendent of Construction on the Development he reported directly to the Works Engineer, and was immediately responsible for the carrying out of the whole of the construction work. He was assisted in his work by the following departmental heads: the Superintendent of Division No. 1, the Superintendent of Divisions Nos. 2 and 3, the Superintendent of the Power House Division, the Superintendent for the construction and maintenance of the Construction Railways, the Plant Engineer, and the Master Mechanic. Mr. Angell resigned in the Spring of 1922 at a time when the work was practically completed and his place was taken by one of the Division Superintendents to discharge the lighter duties then remaining.

WJF.
E-20

Divisional Superintendents

We will not deal in detail with the various duties of the Divisional Superintendents beyond stating that they reported directly to the Superintendent of Construction, and were apportioned certain definite parts of the work. From their written records it would appear that these Divisional Superintendents were all experienced in construction work and were men of the type who would be regularly employed by a contracting organization.

Comment on Nature of Organization

In considering the formation of an organization capable of

should be was without the position of representative for making ex-
planation of the policies but the fact remains that Canada is now stay-
ing.

In his position of superintendent of Canada's relations as the
Dominions is reported directly to the Home Department, and was therefore
responsible for the keeping out of the whole of the Australian work. He
was assisted in his work by the Australian Superintendent under the Common-
wealth of Australia Act. A, the Superintendent of Territories Act, 2 and 3,
the Superintendent of the Power Home Division, the Superintendent for the
construction and maintenance of the Quarantine Station, the Plant
Station, and the Superintendent. Mr. Hamill replied in the Spring of
1912 in a time when the work was practically completed and his place was
taken by one at the British Superintendent's in Australia the Lighter
Active this Province.

Ministerial Responsibility

We will not deal in detail with the various duties of the
Ministerial Superintendent beyond saying that they covered directly in
the Superintendent of Quarantine, and were supervised certain definite
part of the work. From this brief outline reason it would appear that the
Ministerial Superintendent was all encompassed in a subordinate role but
was one of the type who would be especially suited for a subordinate
appointment.

Summary on Status of Commissioner

In summarizing the discussion of the organization appears at

designing and constructing a plant of the magnitude and importance of the Queenston-Chippawa Development, it is apparent that there were two essential factors to be considered: first, that the design called for the very highest type of engineering ability so that the parts might all be properly proportioned and the whole moulded and fashioned into a unit which would function surely and efficiently, and second, that to be truly successful, the Development would have to be built at a reasonable cost.

At this point some comment as to the results obtained is appropriate though in other sections of this report we state in detail the actual working capacities of the plant, its output efficiency and so forth. In short, however, it may be stated that the Development, as built, gives every indication that the engineers of the Commission as designers surpassed even their own expectations. The canal designed to pass 15,000 cubic feet of water per second is said by our Consulting Engineer to be capable of passing 18,000 second feet or more. The engineers hoped to get 30 horse-power per second foot and tests now indicate that this amount will be exceeded. The plant has an efficiency of over ninety per cent.- an unusually high figure and one which indicates a nicety of design seldom, if ever, before attained. To those engineers of the Commission who were directly associated with the design of the plant should go unstinted praise for their remarkable work. Particularly is this so in the case of Mr. H. G. Acres, who was the responsible head and directing force in engineering matters, especially when it is remembered that Mr. Acres shouldered the additional burden of directing construction procedure and, in 1920, because of the ill health

of his principal assistant, took personal charge of field operations.

Distinct from the question of design is that of construction. An excellent design may be rendered economically valueless if built at an unreasonable cost. Effective design calls for technical skill of the highest order. Economical construction is the result of wide and varied experience from which comes the ability to cope effectively with almost every conceivable difficulty. Seldom do we find a perfect combination of these two qualities in one person or in one organization; often they appear in direct opposition, though happily, it may be said, that the professional man is becoming more practical and the builder is gaining a fuller appreciation of professional skill.

The functions of the one, however, still remain largely apart from the other. This fact is almost invariably recognized in ordinary business. The most simple example may be found in the relation between architect and builder, or between a designing engineer and a contractor. Of recent years, organizations combining both functions have come into being, but it will found that within the one organization there really exist two organizations, the one specializing in design and the other in construction.

In the organization directing the construction work on the Queenston-Chippawa Development no such subdivision of authority was made until the position that Mr. Angell occupied is reached. His immediate superior, Mr. Goodwin, and later Mr. H. G. Acres, directed both operations, namely, engineering and construction. The man acting

as superintendent of construction took his orders and carried out the wishes of those who were essentially interested in the thing which they had conceived and planned. It may be argued that Mr. Goodwin, while in active control, took care of this condition, but it must be remembered that he controlled the field engineering as well as the construction forces and was responsible for both to the Hydraulic Engineer, who in turn was responsible to the Chief Engineer. Thus it will be seen that the man who would in the ordinary course be directly responsible for the cost was placed in a relatively inferior position, with no direct means of communicating with the Chief Engineer and no right whatever to report to the Commission.

Having regard to the fact that up to this time the organization of the Commission had been essentially an operating body and not a construction unit, one would naturally think that, faced with the expenditure of many millions of money on work of an entirely new character and under war conditions the Commission would have realized the gravity of the situation and appreciated the importance of appointing the best qualified man procurable to act as Manager of Construction on this work, giving him a remuneration and authority in keeping with the responsibilities involved. The creation of such a position would naturally have carried with it the right to receive instructions direct from the Commission and not through the medium of an organization formed of men whose experience had largely been gained in lines of work other than that of a construction nature.

It is our opinion that cost took second place in the minds of the Commission and in the minds of the engineers in conducting this work, not because they wilfully disregarded the question of cost, but because they were so vitally interested and immersed in the engineering refinements of the Development that the cost automatically assumed a position of secondary importance. Closely allied to this, especially in the last period of the work, was the wild scramble to complete it by a certain date; and everything points to the belief that the unwritten orders were to "complete the work at any cost".

An atmosphere such as this could not surround any organization without affecting everyone connected with it. No superintendent of construction, placed in the position of Mr. Angell, could be expected to control a situation under these conditions. The result was that the unwritten orders were obeyed and the costs increased by leaps and bounds.

The general attitude of the engineers may perhaps be illustrated by quoting evidence given before us by Mr. H. G. Acres:

Q.- You were so much concerned, at this time, with the importance and difficulties of the work you had in hand that you devoted your attention exclusively to try to get it through?

A.- Undoubtedly.

Q.- Regardless, in one sense, of the cost of doing it?

A.- Well, in this way, Mr. Rowell, I think I can explain it in this way:..... I just say this in a general sense - if I had given preference to the question of shaving

It is our opinion that such second place in the minds of the investigator and in the minds of the workmen in conducting this work, was because they actually disregarded the position of coal, but because they were so totally interested and immersed in the engineering refinements of the development that the mere mechanistically measured position of secondary importance. Closely allied to this, especially in the last period of the work, was the mild amusement in endeavoring to a certain degree, some speculation points in the belief that the experiment might be "complete the work as far as".

An adequate method of this could not be attained by speculation without effective measures implemented with it. No substantiation of assertations, plans or the results of it, overall, would be expected to material a situation under these conditions. The result was that the engineering models were closed and the mines bulkhoaded by large and heavy.

The general attitude of the engineers may perhaps be illustrated by quoting evidence given before us by Mr. H. G. Agnew:

> Q.- You view as work conducted, in this line, with the performance and attributes of the mine you had to hand that you further just situation satisfactorily in try to put it through?
>
> A.- Definitely.
>
> Q.- Impossible, in one respect, of the most of doing it?
>
> A.- Well, in this way, Mr. Howell, I think I can explain it in this way---- I just was only in a general sense - if I had great pretension in the quality of doing

pennies at the expense of an efficient, durable and workable installation, which would not only serve this generation, but generations to come, hanging would have been too good for me, because it isn't the cost of this thing that is going to count ultimately, it is what the project of that development is going to do for humanity .... and the question of capital cost will be forgotten, absorbed and wiped out long long before that plant is superseded by any other form of energy .... For instance, if I saw that I was going to exceed cost, in any degree, and saw the possibility of saving my face .... by putting a little less sand, or a little less concrete, or a little less cement here or there, and so on, to cover up that increase, as I say, hanging would have been too good for me.

Q.- Of course, you would hardly describe an increase of $45,000,000 to $65,000,000, Mr. Acres, almost double the original estimate of installation, as shaving pennies, would you?

A.- ..... I wasn't discussing the question from that aspect at all, I was speaking of what it would lie within my power to do as the man in charge of that work, if I had wanted to scamp the work to cover any possible excess cost .... You see, I made it my business to see, in connection with the work done there, that quality came first. Ev. 4196-7

Mr. Acres is correct when he says that cheapening a job at the expense of the materials or workmanship entering into it should not be countenanced, but as pointed out to Mr. Acres, the manner of "shaving pennies" is not the question. The whole of Mr. Acres' evidence supports our view that quality of workmanship and refinement in design were continually given first consideration and the matter of cost took second place.

It is also apparent that, as the work proceeded, those directing it came to the conclusion that they were no longer in control of the situation and that it was useless to do anything other than push operations to a conclusion. Bearing out this opinion we would quote further evidence given by Mr. Acres:

pension of the expense of an efficient, flexible and variable installation, which would not only cause this penalties, but questions to come, dredging costs have been too good for me, however it isn't the cost of this thing that is going to cause stalemate, it is what the yardsticks or risk envisaged is going to do for security .... the granting of adjustment will be troublesome, arrears and signed not long ago before that point is approached by any other form of security .... for instance, if I saw that going to cause trouble, in my figures, and see the possibility of varying my base .... by putting a little line down, or a little line somewhere, or a little line cement here or there or there, and so on, to cover up that increase, yes I say, something would have been too good for me.

Q.- Of course, you would hardly describe an increase of £40,000,000 to £80,000,000, Mr. Arrey, almost within the original estimate of installation, as another question, would you?

A.- ..... I wasn't discussing the question from that angle at all, I was discussing of what it would lie within my power to do in the case in change of that work, if I had wanted to change the work to cover my possible arrears ..... Yes sir, I take it my balance is one, in connection with the work that there, that really was there.

Mr. Arrey is correct when he says that disagreeing a lot on the expense of the materials or workmanship entering into it should not be mentioned, but as pointed out to Mr. Arrey, the meaning of "adverse premium" is not the question. The whole of Mr. Arrey's evidence supports our view that quality of workmanship and reliance to design was unusually given first consideration and the matter of cost been secondary plans.

It is also apparent that, as the work progressed, Sir Alexander it seems to the commission that they were no longer in control of the situation and that it was useless to be supplying other than yes questions to a questioner. Bearing on this opinion we would quote further evidence given by Mr. Arrey:

Q.- Now, will you tell me when you first discovered that the estimate of Twenty-Seven Millions would be quite inadequate to complete the work?

A.- In 1920.

Q.- What time in 1920?

A.- In the spring of 1920.

Q.- Did you report on that at that time?

A.- I did not make a written report, Mr. Rowell, I simply reported that, as far as estimates were concerned, I was beyond my depth ..... That the conditions had become such that estimates no longer meant anything as far as I was concerned.. Ev. 4185

Again, in questioning Mr. Acres as to making a revised estimate of the cost when it was realized that original estimates no longer applied, the following statements were made:

Q.- You could have made an estimate?

A.- Yes, sir.

Q.- And you could have advised the Commission at that time, if you had been requested to do so?

A.- Yes. The procedure, in a case like that, would have been to shut down the job entirely, discharge all the working force, and get to work to find out where we stood.

Q.- Well, would it be necessary to do that before you could estimate what it was going to cost you to go ahead and finish?

A.- It would have been absolutely impossible to do it in any other way, sir. Ev. 4193

In spite of this statement it will be noted in previous sections of this report that Mr. Hugh L. Cooper was engaged to make an estimate which he did while construction operations were in progress. Later, Messrs.

Q.- Then will you not be then you never discovered that the [illegible] of Transylvanian citizens would be [illegible] to complete the work?

A.- No idea.

Q.- That time is later?

A.- In the spring of 1941.

Q.- Did you report on that at that time?

A.- I did not send a written report, Mr. Donald, I simply re-[illegible] that, as far as evidence was concerned, I had [illegible] by [illegible]. That the conditions in Rumania were not [illegible] to Jewry insofar as for as I was concerned.

Again, in questioning Mr. Kamm on the making of written notes of the part then it was evident that verbatim statements in Hungarian [illegible] the following exchange took place:

Q.- You could have made an estimate?

A.- Yes, sir.

Q.- And you would have stated approximately at that time, if you had been requested to do so?

A.- Yes. The procedure, in a case like that, would have been to send back the Jew politely, thanking him for the [illegible], and let it be clear not there to stay.

Q.- Well, would it be necessary to do that before you could estimate what it was likely to mean if you be sent to Dachau?

A.- It would have been absolutely impossible to do it in any other way, sir.

In spite of this evidence he will be asked in another [illegible] at this report time Mr. Donald. Perhaps the [illegible] is [illegible] in the [illegible] demonstration [illegible] the [illegible]. Thank, Mr.

Stuart and Kerbaugh made an estimate under these same conditions. The statement made by Mr. Acres can mean only one of two things: either that his staff were so overwhelmed with the direction and operation of the work that they had no time to make an estimate, or that any estimates made during the progress of the work, either by his own staff or by outside experts, were valueless. We have shown elsewhere that Mr. Acres fully endorsed the estimate made by Stuart and Kerbaugh, and it would seem that the first reason given is the one which Mr. Acres had in mind.

It is quite conceivable, and we believe very probable, that if the construction work had been entirely under a separate management conditions would not have reached the chaotic state which they apparently did. The very act of vesting in a manager of construction the responsibility for conducting this work on an economical basis would have tended toward decreasing the cost. There is no doubt that the modifications and improvements made from time to time in the design would have disturbed the best laid plans, but the man best qualified to meet conditions of this character would have been one placed in entire charge of construction, supported by a wide knowledge and varied experience on work of a similar nature.

Labour Controlled Situation in 1921

We have pointed out elsewhere that instead of wages decreasing and efficiency increasing on this work in 1921, the reverse condition took place. We have illustrated this by referring to charts which have been prepared by our Consulting Engineer. The fact is also illustrated by referring to table of wages paid, given on page 320 of this report.

As a further indication of what actually took place on this work we include herewith figures prepared by our Consulting Engineer showing the total average monthly earnings per man during the period 1917-1921. Mr. Francis in his report sets these figures out in detail for each month and in each year, but we will repeat here only the figures as they average over each year. Mr. Francis says:

".... the average monthly earnings per man for the years are seen to be:

1917	$ 96.90
1918	118.65
1919	143.20
1920	159.98
1921	162.08

WJP.
M-20

The rise in percentage over and above the average monthly earnings in 1917 per man per year, is 22% for 1918; 48% for 1919; 43% for 1920 and 67% for 1921."

It will readily be seen what an attractive thing it was for labourers and mechanics to secure work on this job which paid such handsome wages.

In this connection, it is interesting to note comment appearing in the press at that time. Under date of June 19th, 1922, we find an article under large headlines appearing in one of the Toronto newspapers under the following caption: "HARDER WORK, HALF THE PAY, NOW THE RULE IN CHIPIAWA". In the body of the article, a discussion of rates of wages paid by the Hydro for unskilled labour in 1921 is given, and these are stated to be 50 cents to 60 cents per hour. The scale of wages paid by contractors who at a later date

[illegible]

were employed by the Commission to do work is then stated to be 25 cents per hour. The article shows that "Laborers' loss under contractor's pay, per day", is "$1.50 to $2.50". The article continuing says:

> "To have to work two hours more a day for $2.00 less pay per day has been the laborers' net 'gain' from the outcry 'Adam Beck is bolshevising Ontario with his high wages and easy hours on the Chippawa'.
>
> "'High wages' and 'easy hours' have gone. The sample quoted, ten hours a day for 25¢ an hour, is the most glaring contrast with 1921 condition, experienced in Chippawa district. That was the rate offered and enforced until recently by contractors on one section of the canal."

Later, in referring to the condition of the merchants in the vicinity of the Development, the article states:

> "Gone are the days when merchants here sold foreign workmen fifteen dollar shirts three at a time, and boxes of silk hose at $2.50 a pair. That was just a year ago when laborers by the thousand were getting 50 cents an hour on the Hydro's big development canal and 8,000 men on the payroll of that company poured more than a million dollars a month into the city of Niagara Falls and its vicinity.
>
> "Overtime was plentiful then and wages for skilled and unskilled labor at its zenith."

The same paper on June 21st, 1922, contains an article lamenting the passing of the prosperous days of 1921 as follows:

> "A steady job and good pay was the ordinary order of events while the development canal was being built. Hydro was the leaven keeping labor in all industries well paid."

Again:

> "There is no overtime or night work on the 'big ditch' now, and laborers get 35¢ an hour instead of the 50¢ minimum earned when Sir Adam Beck had a free hand.
>
> "Despite this, and the 10¢ an hour cut in the wage of skilled workmen, which was made last August, both laborers and mechanics think themselves lucky when employed by the public ownership enterprise."

The foregoing quotations illustrate, we believe, with fairness, the general attitude of labour in respect of this work. We have said elsewhere that this was regarded by the men as a Government job and Mr. Cooper, in his report before quoted, adequately sums up the situation when he says:

> "The outstanding, universal explanation of this difficulty of labor is found in the fact that a rich Government is paying for their time."

Government must face large Expenditures in near Future

The situation facing Ontario at the present time is not dissimilar from that encountered during the years 1915, 1916 and 1917 when the necessity for a large supply of power became apparent, resulting in the construction of the Queenston-Chippawa Power Development. Our Consulting Engineer informs us that power from the Queenston-Chippawa Development is being absorbed as quickly as the Commission find it possible to get the generators installed. We understand that by December of this year or not later than January, 1924, six of the nine or ten units will be installed, and in operation. The first unit was delivering power to the Niagara System early in 1922, so, in two years' time, half the supply of the Development has been absorbed, and it is probable that the balance will be absorbed just as quickly.

We believe that the Commission are at the present time planning measures to meet the power shortage when it occurs, for we see comment in the press referring to the various schemes. The construction of a second development in the Niagara Peninsula has been under discussion for some time. The development of power by utilizing the St.

Lawrence River is a project to which much publicity has been given. Of recent date the construction of a steam plant to supplement the supply of electric energy has been proposed.

Any one of these plans would require the expenditure of many millions, and it is our belief that the demand for power will soon make necessary the commencement of operations, almost simultaneously, on more than one of the projects which have been mentioned.

We have shown that the preliminary studies of the Queenston-Chippawa Development extended over a period of years prior to the time actual construction was commenced, and that the construction period alone extended over a period of nearly four years before the first unit was installed. Before the plant is finally completed a period of six or seven years will have elapsed. While the art of hydro-electric power development has advanced considerably during the last decade, and although the engineers of the Commission have undoubtedly contributed as much as any other body of men toward this advancement, the working out of plans and details for any great project necessarily takes much time, even though the subject be well understood.

We are of the opinion, therefore, that no time should be lost in instituting the planning of new works to provide for the future demands of this Province. We have shown that a similar demand has existed in the Province of Quebec, where the horse-power development per capita is almost

identical to our own. In Quebec we find private interests planning for new and larger developments, construction work on some of which is already in hand, and contracts for others are now being let.

Government Control and Responsibility

The matter referred to in the above sub-heading has been discussed at length in the report of this Commission entitled "History and General Relations". That report necessarily dealt with this subject in a most general manner but it was clearly shown that the Government must provide some definite and systematic method of communication with the Commission if it is to keep itself informed as to the operations of the Commission.

This report, dealing as it does with the largest undertaking controlled by the Commission and one which, on completion, will represent probably half of the total investment in respect of Hydro undertakings, shows most conclusively that our remarks in reference to Government responsibility and control are founded on fact. It is impossible to summarize the details of our discussion in this respect, but the facts show clearly that the Government was led, regardless of its own policies, into expenditures of more than twice the amount contemplated by it, without being given an opportunity to know the facts or to consult with the Commission until too late.

The relationship between the Commission and the Government

during the period of construction and especially in the later years, was anything but harmonious, and the Chairman of the Commission, time after time, showed an impatience with any desire on the part of the Government to ascertain in what manner its own funds were being expended.

Future Construction Policy

For a discussion of the manner in which the Government may best be kept informed of the operations of the Commission, we would refer you to that section of the report of this Commission entitled "History and General Relations" wherein the matter of Government responsibility and control is dealt with. At this point we desire to make some comment as to the policies which should be adopted in the future if large works are to be constructed.

Throughout this report we have dealt in detail with the work as directed by the engineers of the Commission, and while we fully endorse the work of these men insofar as design and other technical matters are concerned, we have found it necessary to adversely criticize estimates prepared by them and the manner in which the work was managed and conducted. In introducing the discussion of reasons for increases in estimates and costs, we pointed out that our analysis had been made on the most conservative basis possible, consistent with the nature of our inquiry. It may not be out of place, therefore, to again state that the figure of excess cost, which we reached, must be regarded as a minimum, for, under more critical investigation, we believe the amount of this excess cost would be considerably increased.

We do not think it unnatural that the engineers of the Commission wished to construct this Development themselves, for there undoubtedly was a desire in their minds to create almost with their own hands the thing that they had conceived, and one which undoubtedly is somewhat unique in hydro-electric power development. We do not regard the magnitude of this work as its unusual or difficult feature, for, as a matter of fact, there was nothing in the general nature of the work greatly different from other works of large size. To form a proper mental picture of the magnitude of the work, we may consider all the excavated material, which amounts to 18,000,000 cubic yards, loaded on railroad cars. A train large enough to carry this material would be made up of 300,000 cars, stretching practically from Toronto to Calgary, and would take, when travelling at 25 miles per hour, over three days to pass a given point. Impressive though this is, it is interesting to compare the size of the work with another great engineering undertaking,- the Panama Canal. Using the same illustration we find that a train to convey the excavated material from the Panama Canal would be formed of 3,800,000 cars, would take six weeks to pass a given point and would be so long that it would more than encircle the earth at its equator.

It is rather, then, to the general conception of the scheme that we refer when stating that the Development is of an unusual character, and when we say it was not unnatural that the engineers of the Commission should have been ambitious to conduct construction operations themselves.

On the one hand it somewhat into the engineering of the Interplanetary studies to emphasize this "Intelligence Elements". For there seemingly was a desire in their minds to speak about this early yet about the other that had developed, and one which undoubtedly is essential unless in Interplanetary Service Intelligence. We do not regard the employment of this term as its usual or distinctive feature, for, as a matter of fact, there was existing in the general nature of the work somewhat different from a series of large ships. It has a proper general process of the magnitude of the work, we may consider all the necessary industrial, which consists in 14,000,000 cubic yards, located on realized zone. A track large enough to carry this material would be made up of 10,000 cars. Approximately Pen Dennis is Tidal [illegible] when considering of to which are lower, are lower edge to good a given point. Experiment shows this is it is interesting to compare the size of the work with another great engineering undertaking,- the Panama Canal. During the same illumination we find that a train is moving the excavated material from the Canal would be formed of 3,000,000 cars, which line can reach a given point and would be so long that it would cover than entirely the earth at its equator.

It is rather, then, to the general description of the nature that we prefer when stating that the Intelligence is of an economic character, and then we say it was not strictly that the engineers of the Interplanetary should have been obliging to consider constructing operations themselves.

Adverse criticism in this matter cannot be directed against the engineers of the Commission, however, but against the Commission itself, for the Commission is appointed by the Government to mould and direct policies and to accept or reject the recommendations of its officers in accordance with sound business practice. The Commission must, therefore, take the responsibility for the excess expenditures that have occurred on this work and for the various acts of omission and commission throughout the entire construction procedure.

The Commission was no doubt aware that all was not well with the work as it progressed, for the engineers, surrounded as they were with troubles, would naturally relieve their anxiety by discussing them with the Commission. The engineers, however, were the servants of the Commission, and, as such, did its bidding, and we think it probable that they were constantly urged by the Commission to continue the work regardless of the conditions or of the costs arising from them, and that they did so in the belief that the Chairman of the Commission would shoulder or dispel adverse criticism, and in the hope that the final result would justify their actions.

It is said that experience must be paid for, and the experience gained by the Commission when constructing the Development is no exception to this rule; indeed it has been gained at a cost which we hope will never be incurred again, for we can only come to the conclusion that the Commission

should be required to confine its activities entirely to matters of operation and design in the future leaving construction to those whose business it is.

Question No. 5 of the Letters Patent asks whether the methods of construction, supervision and management can "justifiably be continued for the economical completion of the work". We have dealt, in this report, with the Development as constructed for six units, but have shown that the Development when completed to the full capacity of the canal is estimated by the engineers of the Commission to cost $82,483,914. At September 30th, 1923, the expenditures in connection with the Development amounted to $68,795,811.53, so it would appear that an additional sum of approximately $13,000,000 will be expended before the work is complete. While one might be inclined to think, even at this date, that economies could be effected by completing the work on a contract basis, it will be obvious after consideration that nothing would be gained by a change of procedure now. A great deal of the work which remains to be done consists of the manufacture and installation of generators which will be done by contract, practically the only important work remaining to be done by the Commission itself consists of the addition to the power house, and a change in procedure at this date would, of necessity, involve undesirable delay.

One other matter to be discussed is that in reference to the employment of independent consultants on future work. The Commission, as we have shown, employed the services of various consulting engineers, throughout the period of the design and construction of this work. We believe that the employment of independent consulting engineers and construction men is wise, and that their employment should be continued, but we are convinced

would be required to realize the maximum economy in methods of operation and design in the future. Leading considerations in these words involves in Ia.

Question No. 5 of the Informal Report asks whether the methods of observation, magnitude and measurement are "particularly in question for the commercial exploitation of the motor". We have shown, in this report, that the Development has complicated in the full capacity of the model is maintained by the engineers of the Institution in mere (CO,NO,etc. of September 1920, the experiments in connection with the Development commenced in 1919,1920,1921,22, as it would appear that no additional use or experimentation will be required before the work is completed. While one cannot be insured in times, what is this date, the commission will be satisfied by completing the work on a reasonable basis. It will be noticed from experiments that actions could be gained for a change of pressure and. A great deal of the work which remains to be done, especially of the investigations and installations of pressure which will be done by commercial, practically the only important work remaining is because by the investigations already which of the addition of the power house, and a change in pressure of this date could, of necessity, involve considerable delay.

The other matter to be discussed is that of responsibility for the employment of Experienced Engineers on Pilot Work. The Commission, as we have shown, deplore the services of making preliminary engineering, throughout the period of the design and construction of this work. We believe that the employment of independent consulting engineers and commission has also, and that their engineers should be continued, but on a new contract

that their employment should be at the discretion and with the co-operation of the Government, rather than directly under the Commission. We believe the Government, when financing projects of this character, should obtain the independent advice of experts appointed by it. We believe that the engineers of the Commission are probably as highly qualified as any to plan developments of this character, but it must be remembered that they are primarily concerned with the attainment of perfect results from work financed by Government money as a public ownership enterprise, and cannot be expected to have the broader viewpoint of men in private practice who are always encountering a great variety of problems in commercial life. Moreover, the very magnitude of the enterprise demands the mature judgment of many competent minds, so money so expended is well invested.

We believe that, before a final decision is reached as to the design and construction procedure to be followed on any large work to be undertaken, the Government should appoint an advisory engineering board composed of not less than three members who will examine and report upon the plans and recommendations of the Commission. We believe that it would be well to include as one member of this advisory board the Chief Engineer or Assistant Chief Engineer of the Commission, so that there may be direct touch between the independent consultants and those directly responsible for the design. A board so appointed would have its majority composed of men outside of the Government and the Commission, and, consequently, absolutely open-minded as to the projects before them. The Government could feel confident that in accepting its decisions they were receiving independent advice of the highest order.

In giving the opinions contained in this report, and making these last recommendations, we have not overlooked the fact that the completed work is admirable; nor do we, by criticizing adversely when such criticism is required, withhold the credit due to those who did the work. In point of design and quality of workmanship the Development will remain, in years to come, a monument to the skill of the engineers and artificers of these times.

P/
23/ (1) [illegible] [illegible] [illegible] [illegible]

Is this Ch. + not proceeding on the comparative analysis of what might have been done with what was done, upon a | revised of superfluous. ?